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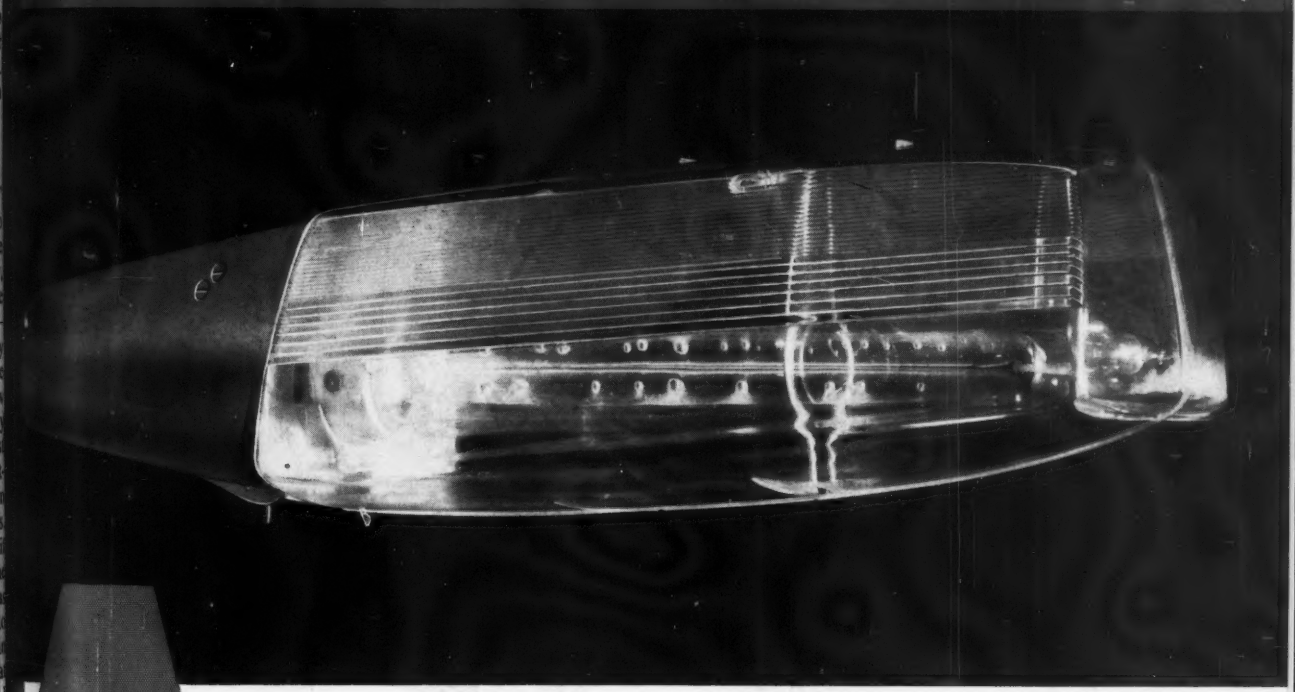

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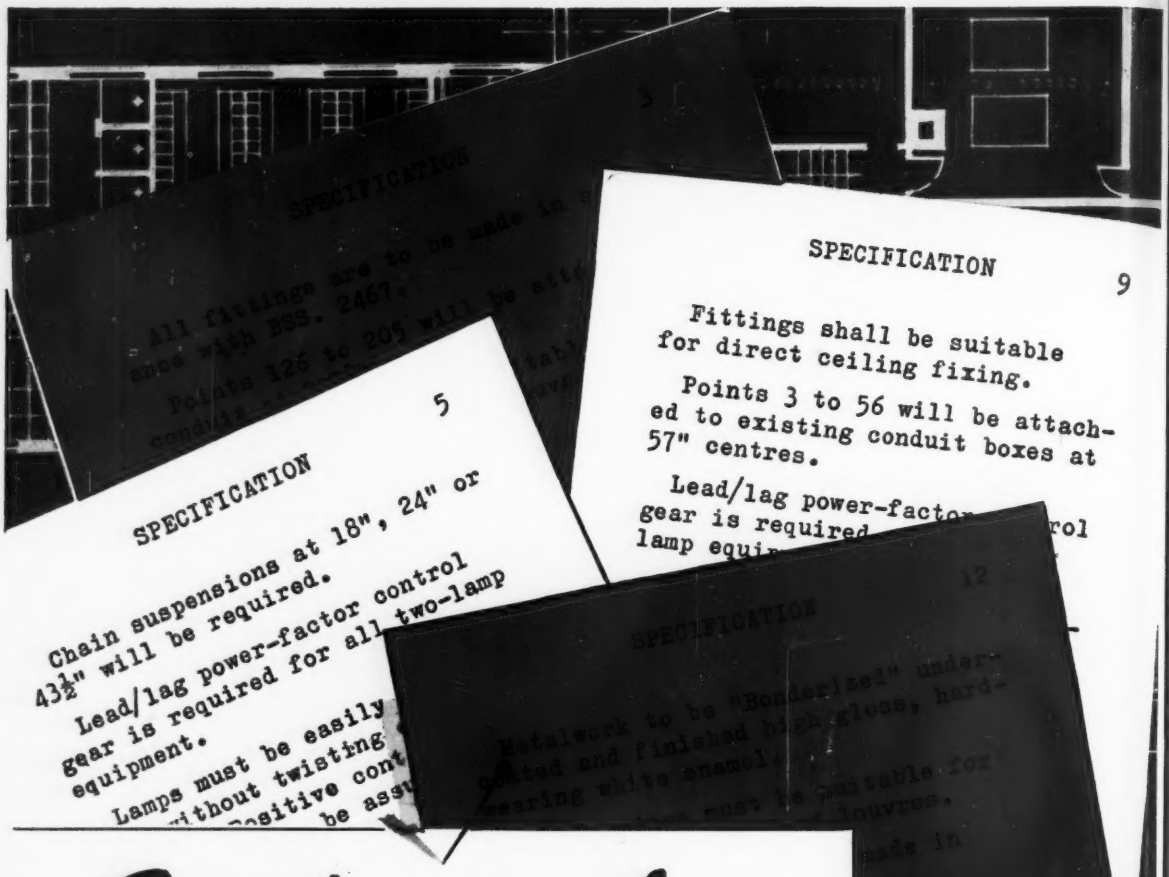
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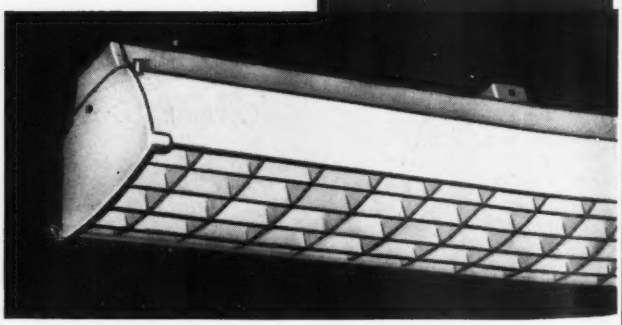

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ELECTRICAL EQUIPMENT

Light and LIGHTING

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Ex luce lucellum

THE tag which introduces these remarks means "a little profit out of light"; it was used by a Victorian Chancellor of the Exchequer who proposed to put a tax on matches. The light of a match is transitory and of low revealing power but, on occasions, may be very precious. However, the point we wish to make is that taxes on necessary light are never justified in our view. The old window tax was iniquitous and will not be forgotten so long as memorials of it survive in the shape of bricked-up window spaces in many extant buildings. By increasing purchase tax on lamps and other lighting equipment in the recent Autumn Budget "a little profit out of light" has once more become a regrettable objective of the Exchequer. But there is something else we deplore in this misbegotten Budget—namely, a tax on enlightenment. We refer, of course, to the increases in postal charges which, for technical and scientific publications like our own, are very serious and must inevitably rebound on all who need the information communicated through these channels. No adequate excuse for imposing these increases has been forthcoming: they are likely to maintain the profits of the Post Office but they are certainly not anti-inflationary.

Notes and News

THE rebuilt State Opera House in Berlin's Unter den Linden was opened last September and rather surprisingly, perhaps, it is in the tradition of the original building by Knobelsdorff, the architect who worked under the patronage of Frederick the Great and gave expression to that monarch's penchant for French art and culture. Thus the lighting of the auditorium and the various rooms, vestibules, corridors and staircases is provided by numerous chandeliers, each with a profusion of glass lustres and electric "candles." An example will be seen on page 42, which shows the "Apollosaal," originally a banqueting hall but now the grand foyer of the new Opera House. It will be seen how well this form of lighting suits the rococo tendencies in the internal decoration of the building.

'Habitation 56'

Following Sweden's sensational "H55" held last year in Hälsingborg, Brussels is to stage an exhibition called "Habitation 56" from May 19 to June 3. The attractive site chosen for it is at the corner of Boulevard General Wahis and the fine new Avenue Leopold III leading to Brussels Airport. The exhibition will cover every aspect from construction and building equipment to interior decoration, furnishing and town planning. Manufacturers participating in this exhibition are likely to obtain particularly valuable business since Belgium is now preparing for the 1958 Universal Exhibition. The new public works, hotels, roads, etc., planned by the Belgian authorities will so tax the country's resources that foreign products and methods will be much sought after.

"Habitation 56" can be described as a Belgian Ideal Home and Building Exhibition combined, is quite new for that country, and will attract very great public and professional interest. Firms interested in participating should contact the British agents, Willoughby and Young, 6a, Smith Street, S.W.3.

Light Irradiation in Horticulture

During the sixteenth International Horticultural Congress held at Scheveningen in the autumn, six papers were presented dealing with the use of artificial light for plant growth. In addition, a symposium was devoted to the subject of photoperiodism (the effect of the length of the daily light period on the flowering behaviour of plants) and two special meetings of delegates interested in the applications of artificial light were held.

At one of these special meetings representatives of several countries discussed the problems and methods of light measurement. As a result the Congress at its closing session unanimously adopted a resolution emphasising the necessity for measurement in terms of energy units, and not illumination units, to be used in conjunction with either the spectral energy distribution diagram or a table giving the percentage radiant energy in certain specified bands.

Another meeting attended by representatives from nine countries discussed the preparation of an annual bibliography of published information on the subject of artificial light irradiation and the possibility of setting up comparable experiments on an international basis to clear up some of the apparent differences in the results obtained in different countries.

Papers on light irradiation were presented by authors from Belgium, France, Netherlands, Norway and Britain. J. G. van Onsem (Belgium) in his paper "Artificial Light for the Cultivation of Aechmea Fasciata" discussed the results of experiments in which the effects of different intensity levels, light duration and types of lamp on the growth of young seedlings and on the time taken for these plants to produce their first flowers were investigated. Similarly, T. Kristoffersen (Norway) in his paper "Commercial and Economical Aspects of Plant Production by Artificial Light" outlined the results of his experiments with 65-watt fluorescent tubular lamps and high pressure mercury vapour lamps on various kinds of plants. From the Netherlands, Dr. J. W. M. Roodenburg (Modern Equipment for Plant Irradiation with Artificial Light) described the latest equipment available in Holland for plant irradiation, including a narrow trough reflector for the 5-ft. 80-watt fluorescent lamp.

Prof. R. Bouillenne (Belgium) in his paper "Artificial Lighting in Horticulture with 'Phytor' tubes" described the remarkable results obtained in his experiments with this type of fluorescent lamp, while P. Chaumier (France) read a paper on "The Applications of Photoperiodism in Plants" in which the control of flowering under different growing conditions was discussed. Finally, a survey of British lamp types, including a discussion of their merits as sources for horticultural purposes, and a description

of present British practice in the use of light irradiation was given in "The Electric Lamp in British Horticulture" by A. E. Canham.

It was evident not only from the papers themselves but also from the interest shown in them that artificial light irradiation has an important part to play in the horticultural industry of the world in general and in the countries of North-West Europe and Scandinavia in particular.

A New Headlamp

A new method of reducing glare from vehicle headlamps is incorporated in a headlighting system now being developed at Battelle Institute, Columbus, Ohio. Instead of lowering and dimming headlights to reduce glare in the eyes of an approaching driver, the system is designed to cast a shadow over that portion of the road occupied by oncoming cars, leaving normal, long-range light on the lane in which the equipped car is driving.

It is claimed that one advantage of the Bone-Midland system, as it is called, is that the driver of an equipped car has as good or better visibility than that obtained with present undipped beams, but his headlamps will throw very little light toward the approaching driver. It is expected that seeing distance with the new headlamp will be between 500 and 1,000 ft., even while meeting and passing an approaching vehicle.

The main design problem has been in connection with the electrical system to control the position of the shadow in the opposing lane. When no car is approaching the lights cover a normal width; when a car appears in the opposite lane a photosensitive cell reacts to the light from the left headlight (assuming driving on the right of the road) of the oncoming car. As the car approaches a vane moves in front of the cell to position itself in relation to the oncoming light. By electrical linkage a corresponding vane in the headlight is positioned to cast a shadow over the approaching car, the shadow changing position as the cars approach one another. The system is made feasible by the use of an ellipsoidal reflector instead of the conventional parabolic one, the ellipsoidal reflector allowing a large shadow to be cast with a small, easily moved vane.

Such a system has, we believe, been studied by others interested in vehicle headlamps and the reduction of glare and dazzle. The electronic problems, however, are not simple and it will be interesting to know, when this American system has been given extensive trials, whether they have been solved in a practicable manner.

One thing that disturbs us about such a system, having a horror of gadgets, is that it introduces yet another thing which may go wrong. During the last year or two the Road Research Laboratory has been trying to impress on motorists the importance of maintenance of headlamps. The proposed system would seem to make far greater demands in this direction. Even with our present relatively simple system and in spite of the R.R.L. efforts the importance of maintenance is hardly appreciated by the public or by the authorities. A more complicated headlamp system is unlikely to make things better—rather, we fear, it will make them worse. The Bone-Midland headlamp might well be an important development but it would seem to be one in which care must be taken to ensure proper use.

Photo-electric Control

The control of artificial lighting by photo-electric cells—an idea that we have had cause to mention twice in recent months—seems at last to be catching on. First, there is Norwich Union House—the new city offices of the Norwich Union Insurance Societies, opened recently by the Lord Mayor, Mr. Cuthbert Ackroyd. Here, photo-electric cells, fixed to the front of the building, will control cold-cathode tubing which supplements the main lighting (part tungsten, part hot-cathode) of the ground-floor banking hall. Secondly, it has been announced that some of the famous illuminated signs at Piccadilly Circus are to have photo-electric controls which will switch them on and off as the daylight intensity changes. It is interesting to note that some neon signs normally intended to be kept on all day can hardly be seen when bright sunlight shines directly on them. When this happens, the sign may be made more effective by switching it off; hence the value of photo-electric control, since shopkeepers (so we are told) have better things to do than switch neon signs on and off.

Bare Fluorescent Lamps

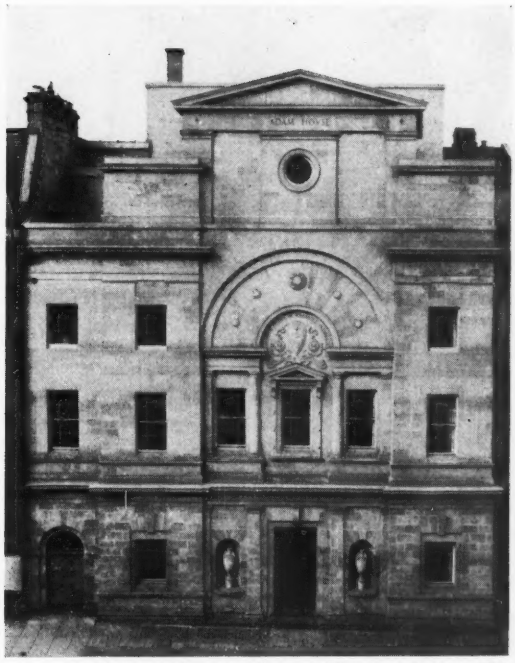
The recently introduced fluorescent lamp with an internal reflector will find many applications particularly in places where it is not possible through limitations of space to install normal reflector fittings or where dust accumulation on lamps and fittings is a great nuisance. We feel, however, that care must be taken that it is not used indiscriminately in bare lamp installation. There is a danger that the amateur might use these lamps to get more light on the working plane, or use less lamps to get the same level of illumination, with disastrous effect. We have had quite enough bother with glare from bare lamps and if the new lamp, the brightness of the effective part of which is nearly twice that of a normal fluorescent lamp, is used in the same way there is likely to be a fresh crop of complaints. Lighting engineers might also watch the matter of specular reflection.

The grand foyer of the re-built State Opera House in Berlin.

Edinburgh University

New Examination Halls

Architects, Rowand, Anderson, Kininmouth and Paul; consulting engineers Mitchell, Day and Lackie; electrical contractors, William Allan Smith and Co., Ltd. Lighting fittings supplied by The General Electric Company, Ltd.



Main, south, elevation to Chamber Street. The stone facing clads a reinforced concrete frame.

SITUATED in Chamber Street, Edinburgh, with classical buildings on either side, Adam House, the new University of Edinburgh examination halls, is a rectangular-shaped building with a frontage to Chamber Street of 58 ft. and a depth of 103 ft. The site falls about 30 ft. from front to rear, i.e., from south to north.

There are six floors, two below entrance level and four above: the sub-basement contains heating, ventilating and electrical services, the kitchen, etc.; the basement comprises a fully equipped theatre/cinema, which can be used also as an extra examination hall; and there is an examination hall on each of the ground, first, second and third floors, that on the third floor being equipped and lighted for use also as a picture gallery.

In general, the entrance hall, staircases and lifts occupy the front part of the building, with the examination halls behind; this arrangement being intended to insulate the halls from the noise of the street. In addition to examinations, the various halls are to be used

The entrance hall. One of the examination halls (it has an undulating ceiling) can be seen in the background, through the glazed partition.

Left, examination hall on first floor, lit by tungsten fittings arranged at the centres of the 24-in. diameter recesses in the patterned ceiling. Below left, basement theatre, lit by similar fittings recessed into the curved ceiling.

for lectures, receptions, dinners, etc.; when used for examinations they will hold about 800, when used for lectures about 1,600. The theatre holds about 200.

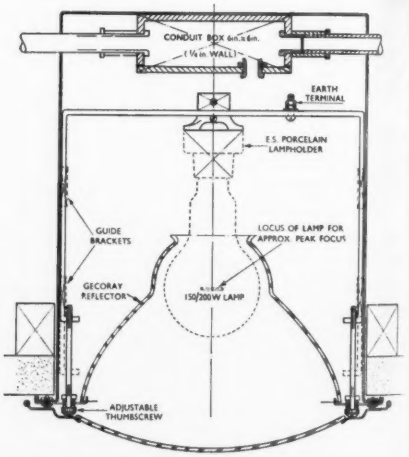
Construction

The building has foundations, frame, floors and roof of reinforced concrete. Walls are of brickwork, faced partly with stone, partly with concrete slabs. Cork composition tiles are used for all flooring, except staircases, lavatories, etc., which are finished with terrazzo. Wall finishes include plaster, marble, and woodpanelling. Suspended ceilings are of plaster on metal lathing.

Two automatically fired solid-fuel boilers provide low-pressure hot water for radiators, and there is a forced ventilation system via ducting.

Lighting

Daylight is available only through the north and south walls and the roof; windows have been introduced into the east wall of the top two floors, but these may have to be built up if adjoining property is extended. For most of the year, therefore, it will be necessary to rely largely on the artificial lighting to provide the required illumination levels.



Section through recessed tungsten fitting. The thumbscrews, which can be manipulated from below, adjusts the position of the reflector, so that the lamp is correctly focussed.

The building is lit mainly by circular recessed fittings comprising a fluted silvered-glass reflector, in a casing covered by a heat-resistant sand-blasted glass dish. There are two sizes: one housing a 300-watt tungsten lamp, one housing a 200-watt lamp. The fittings are designed so that they can be re-lamped and, when necessary, re-wired from below.

On the ground floor, where the ceiling height is 12 ft. 6 in., there are 18 of the smaller fittings and 12 of

The side walls of the art gallery (used for exhibiting paintings) are lit, during the day, by obliquely arranged skylights, one of which can be seen in the photograph above. At night, they are lit by tungsten fittings fixed adjacent to the skylights and focussed on the wall.

the larger, giving an illumination level of about 20 lm/ft², with a consumption of 5.2 watts/sq. ft.

On the first floor, which will be the floor mostly used for social events, the illumination level is 22 lm/ft², achieved by 26 of the larger fittings. Consumption per sq. ft. is 5.45 watts.

On the second floor, the illumination level is 15 lm/ft² and there are 14 of the larger fittings and 22 of the smaller fittings (housing 150-watt lamps), consuming 5.45 watts per sq. ft.

The picture gallery is illuminated by 48 of the smaller units (housing 150-watt lamps), plus four 150-watt floodlights recessed into the walls of each of the six circular laylights, which admit natural light during the day. The laylights are covered by polystyrene louvres. In addition, there are 36 recessed fittings with parabolic reflectors illuminating the side walls on which the pictures are hung.

The Installation

The voltage supply is 3-phase, 415 volts, giving 240 volts at 50 cycles. Distribution is via V.I.R. cable in conduit. Switchgear is in a specially constructed main switch room, where two oil-filled circuit breakers are located before the main switchboard, comprising individual air-break switches mounted on a steel framework.

The circuit breakers are each of 300 amps and are fed by a bus-bar with push-button tripping for emergency purposes. The ironclad distribution boards are re-wireable below 60 amps, but have H.R.C. fuses above this amperage.

Top floor art gallery. Circular tungsten fittings are housed in the suspended ceiling. The laylights, which have louvred polystyrene covers, are each lit at night by four 150-watt concealed tungsten fittings.

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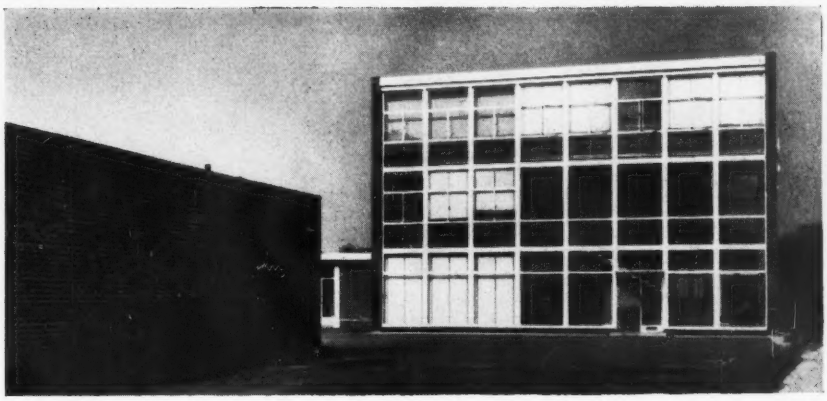

The fully-glazed three-storey façade of the office block. On the left can be seen the brick cladding to part of the production building.

Factory

at Crawley New Town

Architects, J. M. Austin-Smith and Partner, A./A.R.I.B.A.; consulting structural engineer, F. J. Samuely, B.Sc. (Eng.), A.M.I.C.E., M.I.Struct.E.; general contractor, F. G. Minter, Ltd.; electric wiring and lighting fittings, Berkeley Electrical Engineering Co., Ltd.; decorative lighting fittings, Falk, Stadelmann and Co., Ltd.; sunblinds, Danaura, Ltd.

Designed by J. M. Austin-Smith and Partner for a firm that manufactures rubber anti-vibration mountings, this recently completed factory comprises production and administration blocks, both constructed so as to facilitate future extensions. Unlike those of the typical Great West Road factories of the 1930s, the administration block is not designed as a " prestige façade " to hide the works behind; instead, the two blocks are separate and of equal architectural merit.

The site, which has an area of 11 acres, sloped down towards its northern boundary, and the fall of about 4 ft. is accommodated within the factory block by a change in level between the main production shop and its ancillary areas—canteen, lavatories, research laboratory, etc.

Construction

The main production area, which is 236 ft. long and 108 ft. wide, has a floor space unobstructed by stanchions. The north-light roof over it is in the form of prismoidal " shells " of light welded steelwork, and represents one of the first examples of this type of construction to be carried out in this country. The north-light roofing is continued on either side of the production area to cover also the 54-ft.-wide outer bays that house the tool room, plating shop, finishing shop, inspection department and various stores.

The roof is supported at the perimeter of the production shop by built-up r.s.j. columns and at the perimeter of the building itself by load-bearing brickwork. External walls of the factory block are of non-load-bearing brickwork, except for one wall which is clad with asbestos-cement sheeting, to allow for easy dismantling when the factory is extended.

The office block is a T-shaped building, the longer arm of the T being two storeys high and the shorter arm,

Interior of main production building looking toward the machine shop, which receives extra lighting from a continuous strip of high-level windows. Tubular heaters at the foot of the north-light glazing help to minimise condensation.

the top floor of which contains the managing director's suite, three storeys high. On the ground floor is the sales department, the accounts department and, in the shorter wing, the entrance hall. On the first floor is the upper part of the entrance hall, the drawing office, filing room and general offices.

The entrance façade of the three-storey wing is fully glazed, within an exposed framework of box-section welded steel members. The remainder of the office block has beams on a 14 ft. x 21 ft. grid, supported on calculated load-bearing brick piers. Floors and roof are of pre-stressed concrete T-beam construction.

The factory floor is finished with granolithic, the flooring in the offices with wood blocks. The shell roofing is lined with insulation board; areas of flat roofing are insulated by a layer of vermiculite screed. Partitions between the main production area and the ancillary departments are of patent, glazed, metal partitioning; those in the office building are of hollow terra-cotta blocks set in hardwood framing.

Heating

The factory is heated by high-level unit heaters, giving a controlled temperature of 60 deg. F., with three air changes an hour. Hot water for the heaters comes from four oil-fired, cast-iron sectional boilers, which also supply convectors and radiators in the office block, where the temperature is controlled at 65 deg. F., with two air changes an hour. The entrance hall of the office block has floor panel heating. Vertical galvanised calorifiers, with a total capacity of 350 galls., provide hot water supply for cloakrooms, kitchen, etc.

The factory has a floor area of 75,000 sq. ft., including the office block (10,000 sq. ft.). It took 15 months to build, at a cost of about £80,000.

Natural lighting

Daylighting of the factory is principally by means of the north-light glazing, supplemented by a continuous strip of high-level windows in the west wall, which provide extra light for special operations in that part of the production area and admit afternoon sun to counteract the "coldness" of the north lighting. Office windows are metal framed, with vertically pivoted opening lights. Metal venetian blinds are used to reduce glare. Kitchen stores, cloarooms and lavatories are lit by ventilated, dome-shaped rooflights.

Artificial lighting

Artificial lighting in the production block is by means of twin-lamp fluorescent trough fittings. There are two continuous lengths of cable trunking in each bay, and the fittings can be fixed at any points along the trunking, so that illumination levels in different areas may be varied as required. (Up to 22½ lm/ft² can be achieved using only one row of fittings in each bay.)

The offices are also lit by twin-lamp fluorescent fittings, but circulation areas in the office block have decorative fittings housing tungsten lamps.

Illumination levels are as follows: drawing office 60 lm/ft²; fine machinery 30 lm/ft²; production area generally 22½ lm/ft²; offices 20 lm/ft²; storage areas 7½ lm/ft²; circulation areas 5 lm/ft².

Distribution is via P.V.C. insulated cable and screwed conduit in ducts and crawlways. There are two distribution boards for the power installation per row of machines, with 4-way outlet boxes arranged on a regular 12 ft. x 6 ft. grid. Conduit for these outlets is buried in the floor. Associated services include G.P.O. and internal telephones, a loudspeaker system and electric clocks.

West elevation of main production building showing shape of north-light roofing and the strip of high-level windows above the non-load-bearing brick cladding.

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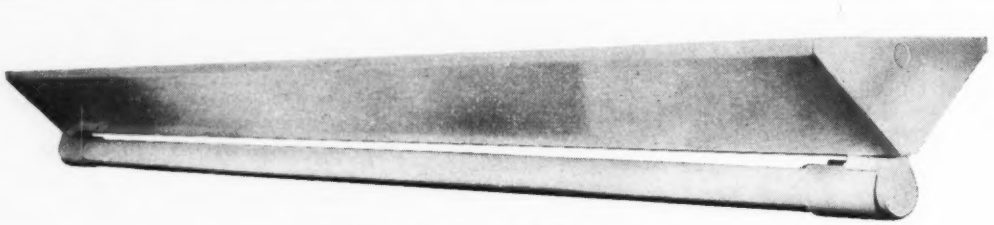

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The Lighting of Tunnels

By J. M. WALDRAM, B.Sc., A.M.I.E.E., F.Inst.P., F.I.E.S.

A discussion of the problems and an account of some studies to solve them.

Vehicular tunnels present a problem in lighting which has never been solved. Such tunnels are not very numerous; each one is lighted by a system which tries to improve on its predecessors and which is an example, sometimes a warning, for its successors. Experiment at full scale is difficult; each country possesses only one or two major tunnels, and installations once made are very difficult to change or improve. The problem is clearly one which should be the subject of model experiments and calculation, and the present article records some preliminary conclusions which may well be criticised by those with more experience of tunnel lighting at full scale.

Construction of Tunnels

Vehicular tunnels are constructed usually either under hills or under rivers; they always carry heavy traffic, for otherwise their construction would not have been necessary. They are seldom quite straight; sub-river tunnels always have changes in vertical curvature. Most of them are for traffic in both directions, but there are some for uni-directional traffic only, using two bores. The section of the tunnel varies considerably, according to the ventilation arrangements and the mode of construction. The section may be rectangular, semi-circular, or of a form intermediate between the two. The tunnel surfaces are always finished in shiny white, usually in white glazed tiles, or in white paint. In the Liverpool tunnel (Fig. 1) there is a black band of glass tiles extending upwards from the deck for about 5 ft.; in some other tunnels there is a raised walkway at the side which in effect produces a dark band at the lower part of the wall.

At the entrances the section is often increased for a length of about 150 ft., or more from the portal. This latter is usually of light coloured stone or concrete; it is approached, in sub-river tunnels, down a sloping ramp between walls of similar material. Tunnels under hills are sometimes approached through a very short cutting, or no cutting, the portal being flanked by apron wells also light in colour.

The usual practice in lighting tunnels is to place lighting equipment on either side at the haunches, either on the side walls or set at an angle between the walls and the roof in rectangular tunnels, or in corresponding positions in round or elliptical tunnels. The placing of equipment at the crown leads to difficult maintenance. In the older tunnels, equipment was usually in boxes set in the walls, but the more modern practice is to use tubular light sources not recessed but mounted on the walls. An illumination of 1—5 lm/ft² is usual, on the deck. Luminances vary considerably; a value or about 1 ft.-lambert is often found, with variations both above and below, in the central part of the tunnel.

At the entrances and exits the lighting is modified during the day to assist drivers in changing adaptation as they run from daylight into the tunnel and out again, and many different schemes have been adopted which will be discussed later. Lighting is usually varied according to the amount of daylight and is reduced at night.

The Special Problems of Tunnel Lighting

A tunnel provides unusual lighting problems in that

(i) the lighting is in use for 8,750 hours per year, and it is never switched off:

(ii) complete failure of the tunnel lighting even momentarily would be disastrous; elaborate duplication of supply and emergency arrangements must be made:

(iii) a tunnel once in service cannot be shut down for repairs or redecoration; maintenance is difficult and sometimes dangerous:

(iv) in order to keep the interior surfaces clean, tunnels are regularly washed with sprays of detergent and water; lighting and electrical equipment must be rigorously watertight.

The great, and so far unsolved, problem of tunnel lighting is, however, to provide adequate visibility of vehicles just inside the tunnel, to a driver who is approaching at speed from outside and who is adapted to luminances corresponding to full sunlight. The other problem is the lighting of the tunnel itself efficiently and economically by a system which will be safe, which will give good visibility of vehicles in the tunnel, without glare, and cheap to run and to maintain. These two problems will be examined, taking the second one first.

Internal Lighting of the Tunnel

The function of the internal lighting of the tunnel is to provide a bright background against which the vehicles are seen. In a sense, the problem is the inverse of the problem of street lighting; in street lighting we cannot rely upon light coloured buildings, and we seek to make the carriageway surface bright to act as a background. In a tunnel, we have complete control of the surroundings to the carriageway, and can do better by making the sur-

The author is Senior Research Illuminating Engineer, Research Laboratories, The General Electric Co., Ltd., Wembley, England. This article is an extract from a paper delivered in June, 1954 to the Association Française des Eclairagistes at Monte Carlo

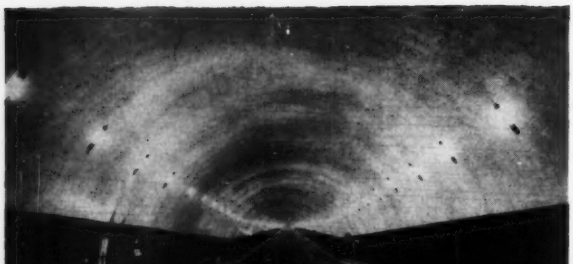


Fig. 1. Liverpool tunnel.

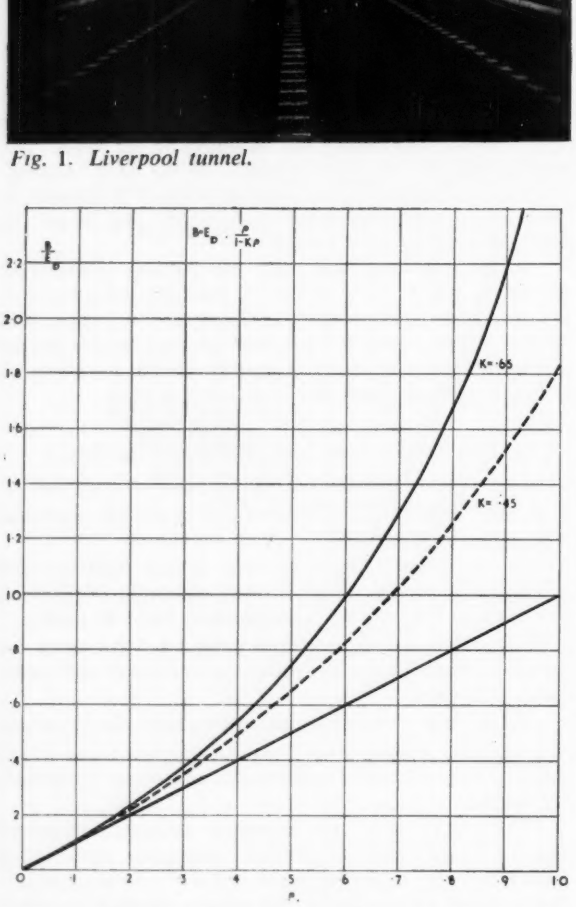


Fig. 2. Effect of reflection factor of tunnel walls on wall brightness for given value of direct light.

rounds bright than we can by making the road surface bright. It is important, therefore, that the reflection factor of the tunnel lining, particularly that part near the carriageway level, should be as high as possible. To make the lower part of the tunnel walls dark, as was done in the Liverpool tunnel 20 years ago (Fig. 1), was a cardinal mistake, and experiments are in hand at Liverpool at the present time to change it.

The light walls of the tunnel bring about inter-reflection, and if the reflection factor is kept high, major economies of energy can be effected. The effects of inter-reflection can be calculated very simply by a method recently devised for interior lighting(1), as follows.

Let the luminance of the tunnel walls be B ft.-lamberts, and the reflection factor of the walls r. Assume that the reflection factor of the carriageway, for the present purpose, is negligibly small.

To produce a luminance B (ft.-lamberts) with reflection factor r demands an illumination $E_T = B/r$ lm/ft². This illumination will be made up of the direct illumination from the lighting equipment, E_d, and from the illumination E_r received from other parts of the tunnel wall. The latter can be arrived at very simply. If the whole of the tunnel, including the carriageway, were of brightness B ft.-lamberts then the illumination E_N of any point of the wall, received from the rest of the tunnel, will be B lm/ft². In a real tunnel, with a dark road, E_r will be less than this, say KB, where K is a factor less than unity, probably about 0.6 for a point a little above the floor of the tunnel. K can be computed precisely, treating it as a problem in daylight, for any particular case. In order to achieve a total illumination of $E_T = E_d + E_r = B/r$ where E_r, the illumination provided by inter-reflection, is KB, we must provide a direct illumination of $E_d = (B/r) - KB$.

$$= B\,(1/r - K) \text{ or } B\,(1 - Kr)/r$$

$$\text{or } B = E_d.\, r/(1 - Kr) \text{ ft.-lamberts.}$$

This function is plotted in Fig. 2 for $K = 0.65$, from which it will be apparent how important it is to keep r as high as possible. A reflection factor of 0.62 causes the tunnel to appear as bright as a perfect reflector would appear without inter-reflection; a reflection factor of 0.8 brings about sufficient inter-reflection to double the luminance of the tunnel due to direct light alone. A drop of reflection factor from 0.8 to 0.6 requires an increase of power of 1.7 times, to restore the luminance of the tunnel. It is very important, therefore, to line the tunnel with material of very high reflection factor which can be maintained in service permanently and which can be restored by washing for, once the tunnel is in service, refinishing the interior is very difficult and very expensive. Moreover, it is important to provide and maintain a regular cleaning schedule, and this is done in all modern tunnels.

The importance of regular washing led to the practice of placing lighting equipment in recessed boxes mounted flush with the tunnel wall, glazed with glass with a watertight seal to the box, a construction which, until recently, was almost universal. The construction is, however, expensive because the recesses have to be provided in the tunnel construction, it permits little alteration, and it is inefficient optically, and likely to deteriorate with time. It is doubtful whether such boxes after some years of service have a light output ratio greater than 0.3 to 0.4. The use of discrete light sources has another and rather unexpected effect, particularly when the gradient of the tunnel changes; it is apt to produce bright flashes from windscreens, and the separate light sources reflect in the polished bodies of cars in such a way as to make them difficult to recognise. If the tunnel section is round, it sometimes happens that discrete lights produce distracting curved reflections in the shiny vault of the tunnel.

In more recent tunnels, such as the Brooklyn-Battery tunnel and the Croix Rousse tunnel at Lyon, the interior of the tunnel is lighted by fluorescent lamps on the tunnel walls with their axes parallel to the tunnel axis and not recessed. This is very much cheaper to install and permits

alterations. Watertight constructions are used which enable the lamps to be washed safely. The light output of such an arrangement is close to 100 per cent., and immediately we have a gain of about two and a half times in efficiency, quite apart from the luminous efficiency of the lamps themselves. In the Brooklyn-Battery tunnel, cold-cathode lamps are mounted in continuous lines, an arrangement which has something to commend it, since flashing effects are impossible, and though the tubes reflect in car bodies the reflections do not appear to move over the car. In the Croix Rousse tunnel the lamps are spaced at 3.83 metres and are fitted with simple and ingenious louvres (Fig. 3). It can be questioned whether the louvres are really necessary, for the luminance of fluorescent lamps seen end-on is very low; and from experience of lighting corridors, and from the appearance of an experimental section in Queens' tunnel, New York, there are grounds for expecting that they could be dispensed with, thereby increasing the efficiency. It is interesting that the most recent tunnel in the United States, the Norfolk-Portsmouth tunnel, uses the same system as the Brooklyn-Battery tunnel, without louvres.

A very important factor in tunnel lighting is the life of lamps. Since in a tunnel they burn 8,750 hours per year, tungsten filament lamps need frequent renewal; such renewal is expensive and sometimes dangerous when traffic is heavy. The very long life of cold-cathode lamps is a real advantage here: they are used in the main part of the Brooklyn-Battery tunnel. "Slimline" lamps, which have also a long life, are used at Croix Rousse in the portals; they are also used in the entrance sections at Brooklyn-Battery tunnel, and in the whole length of the Norfolk-Portsmouth tunnel.

Lighting the Tunnel Entrance

In studying the problem of entering the tunnel from daylight it is important to appreciate its geometry. The tunnel portal and apron walls are usually of light stone or concrete, and in many tunnels the sun at some time of the day falls upon their surfaces which the driver can see, so that up to the moment of entering the portal he is exposed to a field of view consisting of surfaces of, say, 60 per cent. reflection factor illuminated to several thousands of lumens per square foot, i.e., to luminances of the order of 1,000 ft.-lamberts. The view which he wishes to see consists of the tunnel walls and floor, extending, if the tunnel is straight, for many hundreds of feet within the tunnel. This point is very important. If a perspective view of the tunnel mouth is drawn for a straight tunnel, with the boundaries marked of sections of the tunnel 300 ft. long (Fig. 4), it will be appreciated what a small part of the important background is formed by the first few hundred feet of tunnel. The first few feet of the tunnel are lighted by daylight, but the illumination of the tunnel walls is low, for the angle of incidence

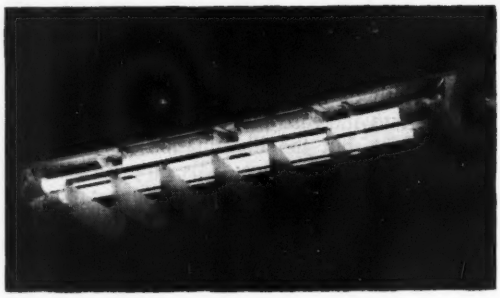
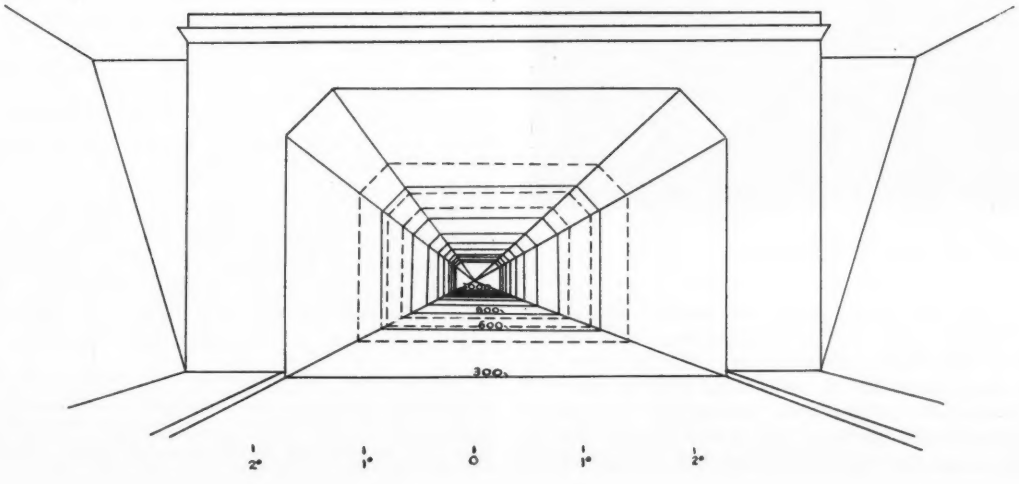


Fig. 3. Croix Rousse tunnel; twin lamp fitting and louvre.

Fig. 4. A tunnel entrance seen from 300 ft. Zones of 300 ft. marked in solid lines.



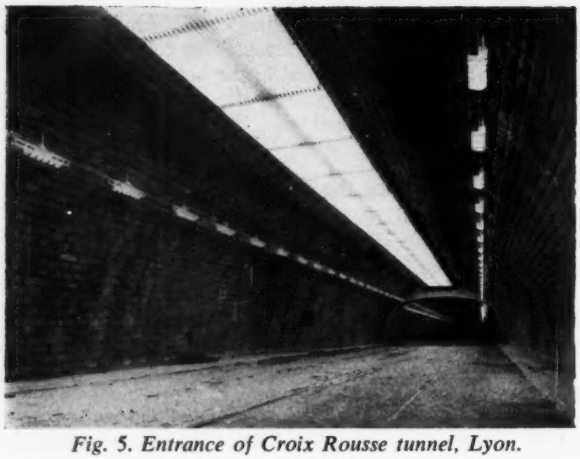


Fig. 5. Entrance of Croix Rousse tunnel, Lyon.

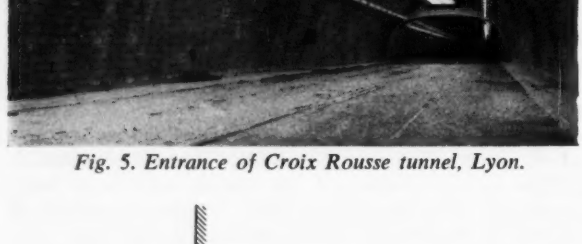


Fig. 6. Tunnel entrance provided with small white louvres. Seen by the driver they overlap to form a continuous background.

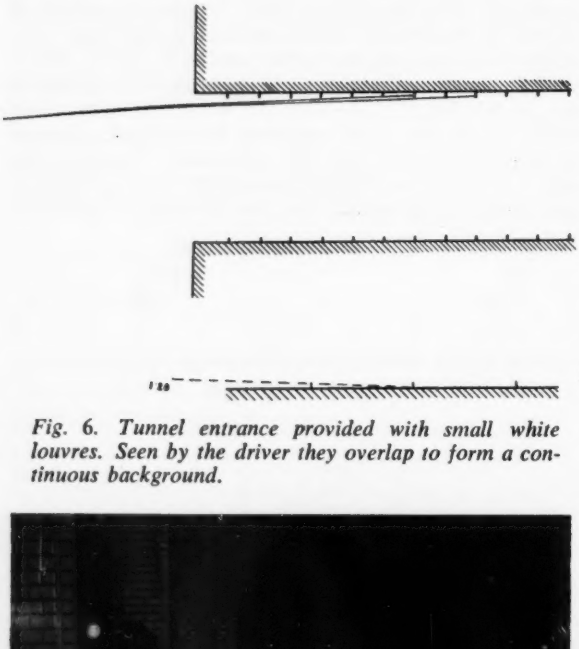


Fig. 7. Underpass, Porte de la Villette, Paris. Retro-reflecting louvres in tunnel entrance.

is great, and the tunnel walls are usually glazed for reasons already stated, so that daylight has a small effect in making the background bright. It has been the practice in all recent tunnels to light the first few hundred feet of tunnel to a high level, sometimes as high as 150 lm/ft² near the entrance, but it will be seen that in a straight tunnel this again will have only a small effect. Various methods have been adopted to provide the extra illumination at the portals. At Liverpool, sodium lamps are used at close spacing, followed by sodium and tungsten filament lamps alternately and, in the middle of the tunnel, filament lamps alone. In the Scheldt tunnel in Belgium, extra sodium lamps are set in the roof at the entrances. The most spectacular is surely the Croix Rousse, at Lyon, with the roof panels of " slimline " lamps and the 3-lamp and 2-lamp fittings near the mouth of the tunnel (Fig. 5). The entrances to this tunnel are larger than the bore of the tunnel and are finished in rough stone instead of white glazed tiles; this design surely results in much lower brightnesses at the entrances than might have been achieved. A recent American installation in a one-way tunnel uses angle reflectors in the mouth of the tunnel directing light down it; this must be an inefficient method, for light so directed will reach the walls at glancing incidence and will be sent on down the tunnel by specular reflection from the glazed surface. Perhaps this results in lighting further down the tunnel than would otherwise be possible.

It has been possible to demonstrate experimentally that the luminance of the background due to daylight at any point can be enhanced greatly by providing small louvres on the tunnel walls, at right angles to the tunnel axis, about 6 in. wide and at about 10-ft. spacing and painted white (Fig. 6); they are seen by incoming drivers as overlapping, and their illumination and, therefore, their luminance at any given point is very much greater than that of the adjacent tunnel wall proper, because they are normal to the incident light. But if this device is tried, it is found that the appearance of the tunnel is indistinguishably different from that of the original tunnel, because the effect of foreshortening so reduces the apparent width of the brighter section. The effect of the louvres is to increase the brightness considerably at any given point, but the illumination of the tunnel diminishes rapidly with distance; it is only necessary to go a short distance down the tunnel to find a point as bright as the first point without louvres. This distance, foreshortened by perspective, appears insignificant.* If it is desired to attain high effective luminance of the background by artificial light, however, the device of louvres has much to commend it. Small louvres of about the proportions described can be formed and can be lighted by fluorescent tubes placed close to them, to a really high luminance: the foreshortening effect causes them to merge into a continuous background at a high brightness, which is achieved at a fraction of the power required to light the whole tunnel. This has been tried on a model, and has been found to function. On a straight tunnel there seems to be no alternative to providing a high brightness for a very long distance if an effective background is to be presented to an incoming driver in sunlight.

The problem can be approached with the aid of the conception of apparent brightness, which has recently been applied to problems of interior lighting(1). It appears that figures of apparent brightness, obtained from the curves devised by Hopkinson in 1941(2), give a useful indication of the experiences of people over a

* Since this paper was written the author has seen a very effective use of this device, using rather wider louvres than here described, in the underpass at Porte de la Villette, Paris, due to M. Gaymard. The louvres were placed in the entrance to a curved tunnel and were coated with a retro-reflecting material like " Scotchlite " and worked most effectively in daylight. The curve of the tunnel avoided the difficulty described above. This experiment may have antedated the suggestion in this paper. See Fig. 7.

very wide range of conditions, taking into account the effects of adaptation: and a rough scale of apparent brightness has begun to appear. For details the original paper must be consulted. From experience with that scale it would be reasonable to provide an apparent brightness of at least 15—20, on the Apparent Brightness scale, as the background needed by a driver entering the tunnel from outside. If he is adapted to 1,000 ft.-lamberts, this would call for a tunnel having a luminance of 115 ft.-lamberts; if the tunnel walls have a reflection factor of 0.75—about as high as is likely to be possible—the direct illumination of the walls from the lighting equipment would have to be 78 lm/ft^2, not merely at the entrance but for a long distance down the tunnel. This would be a very expensive installation.

Reid[3] in America has worked out the necessary illumination at the mouth of the tunnel to allow for the rate of adaptation of a driver entering the tunnel from daylight. But his calculation appears to assume that the brightness of the scene presented to the driver is that of the tunnel walls at the point where he happens to be, whereas, as has been shown already, the scene presented to him is the view of the tunnel for hundreds of feet ahead of him. Reid's curves, therefore, seem to be based on a fallacy.

But the problem can be attacked from either end. We can either raise the luminance of the tunnel, which as has been shown is a major problem and very expensive, or we can reduce the adapting luminance of the incoming drivers, which may be very much less costly. An attempt was made to do this in America in 1939[4] by providing a louvred roof 300-ft. long over the approach to a tunnel, which cut down the adaptation level of the drivers approaching the tunnel. A similar device is contemplated for the tunnel at Le Havre. The effect of such a device can be seen again from figures of apparent brightness. Suppose that we can reduce the adaptation level to 100 ft.-lamberts. Then for an apparent brightness of 20 we shall require a tunnel wall luminance of 12 ft.-lamberts, which with a reflection factor of 0.75 would call for a direct illumination of 8.2 lm/ft^2. This is a much more reasonable proposition; the power required is reduced by a factor of almost 10, and it should be possible to go even further. If the device of illuminated louvres referred to above is employed, the saving of power could be very much greater still, and we have the possibility of a real and economic solution.

The American device of a long louvred roof is rather expensive, and was criticised on the grounds that if snow fell, ice would form below it which would remain unthawed by the sun, and a very dangerous situation could result. There are, however, other possibilities. If the tunnel designers could be persuaded to finish the portals and apron walls in black instead of in light stone or concrete using, for example, polished black glass or marble (provided that the sun cannot reflect directly from it) the situation would be much improved. It would probably not, however, be sufficient in itself. A driver drives by what he sees about 300 ft. ahead of his car at 30 m.p.h. Thus he should be adapted to about 100 ft.-lamberts when he is 300 ft. from the tunnel portal, plus a further distance to allow for the time taken to adapt. In practice, at these levels adaptation takes place in a fraction of a second; however, if we allow two seconds for safety it follows that he should be presented with a large field of not more than 100 ft.-lamberts when he is 380 ft. from the portal. A simpler and probably cheaper device than the louvred roof would be a set of screens, similar to photometer screens. A possible arrangement was tried on a model, shown in Fig. 8, with the results shown in Figs. 9 and 10; the idea certainly seems to be

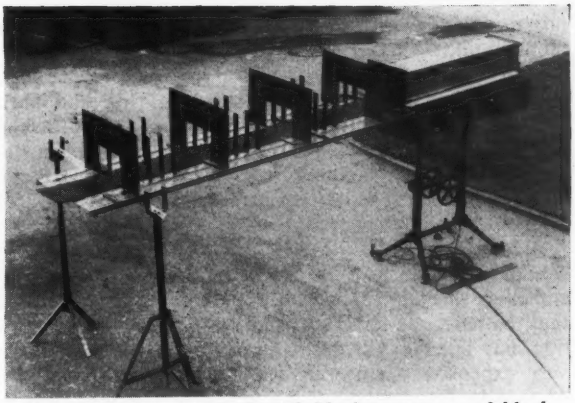


Fig. 8. Model of tunnel, with black entrance and black exterior screens; full sunlight.

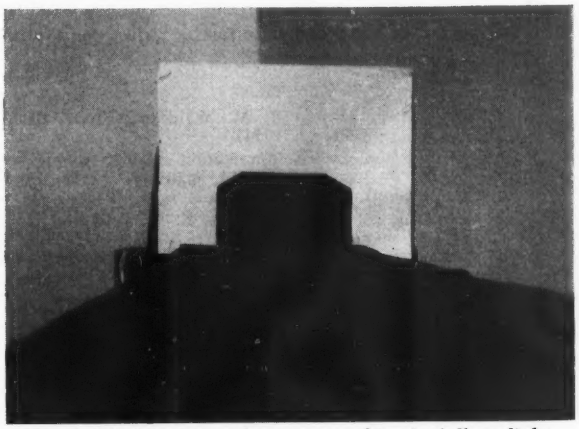


Fig. 9. Model of tunnel entrance, white, in full sunlight. The interior louvres on the left-hand side are lighted.

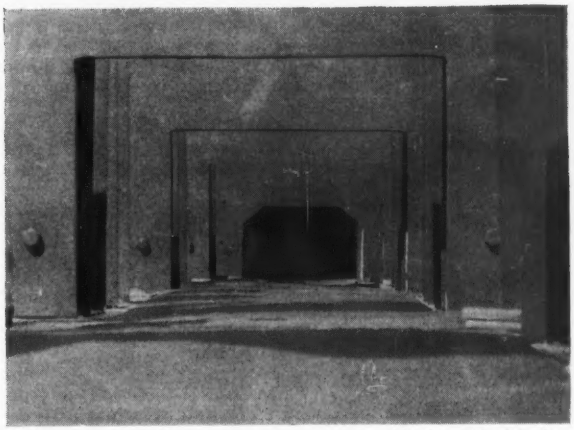


Fig. 10. Model of tunnel entrance, black with black exterior screens, in full sunlight. The small interior louvres on the left-hand side are lighted.

promising, and its full effects cannot be shown on a photograph.

For a double carriageway road, however, the structures would be fairly large; say 90 ft. wide and 42 ft. high, and small subsidiary screens are needed. The effective reflection factor of the screens could be made very low by using smaller horizontal louvres upon them. The road surface should be rough and dark, for example a large-texture tar macadam.

The structures indicated are not beautiful; but it would surely be possible for a competent architect to embellish them, perhaps with designs in colour, provided that the reflection factors used are not high. The proposition may not be as fantastic as it sounds. A tunnel is a very expensive engineering work costing many millions of pounds. The lighting of the tunnel is a running charge, and quite a large capital expenditure is justified if it will reduce the running charge by a substantial amount. Some experiments might be made on these lines to see whether we can obtain a real and practicable solution to this difficult problem.

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Correspondence

Lumination Levels

Dear Sir,—I would like to offer a few comments on the "Postscript" by "Lumeritas" in your issue of December, 1955.

I can hardly think that my writings on artificial lighting are quite as amusing as "Lumeritas" tries to make out—they are not meant to be so, but are really intended to be taken very seriously and are purposely written in very simple and unconfusing language, in the hope that everyone will be able to understand them.

On the question of intensities "Lumeritas" states that our grandparents brought their fine work and small print close to their candles or oil lamps and no doubt they often did, but what about the very tiny print of so many Victorian Bibles and Prayer Books, which were read in churches and chapels lighted by oil lamps or candles? These were not a few inches or a foot away but were suspended at least several feet above the congregation, so that there cannot in most cases have been more than a fraction of a foot-candle by which to read such tiny print.

I would also point out that as recently as 1922, the Departmental Committee on Lighting in Factories and Workshops, in the third report, recommended 3 ft.c. for "fine work" and 5 ft.c. for "very fine work," these values being a very considerable increase on previous recommendations. Yet nowadays one finds 20, 30, 50 and more ft.c., being advised, at a time when everyone is anxious to economise owing to the high costs of coal, gas, electricity, high income tax, purchase tax and so on. If one can see comfortably with so much less, why gaily have so much more than is necessary? Apart from possible harmful effects to our eyes, there is the damage to our pockets! That people so readily accept these and other extravagant suggestions seems to indicate an appalling waste of the millions spent on so-called "education."

Regarding the high intensities of daylight, I would point out that this is the natural light for which our eyes are adapted, and that the sun is not there merely to give light but that it has to generate an enormous amount of heat, in the course of which it inevitably gives off a very greatly unnecessary amount of light—as is shown by the large number of tinted glasses to be seen whenever the sun is shining at all strongly. "Lumeritas" should also remember that we can see well by very low intensities of daylight, as for instance when we are reading out of doors or perhaps playing tennis on a summer evening till some time after sunset.

It would seem that the only people who benefit by the use of excessive artificial light are the suppliers of power, lamps, and all the other accessories that make up such an installation—and those who prescribe and supply spectacles!

On the subject of shadows, "Lumeritas" has his little joke about "umbricians" and so on, but surely it is very desirable, and indeed delightful, to be able to sit in any corner of a room and facing in any direction without having to trouble about the light and without requiring any additional lighting, and if this result can be obtained with only one fitting and one lamp in it, why have numerous fittings and lamps dotted about the place?

London. G. V. DOWNER.

Maintenance Factor

Dear Sir,—The problem of nomenclature has always harried the lighting world, or at least that part of it which seeks for some sort of precision in the matter. Usually those least concerned are the practising lighting engineers who traverse well trodden paths in blissful disregard of the niceties of definition. There is one well trodden path, however, which badly needs resurfacing for it is likely to cause even the most down-to-earth lighting engineer to stumble.

In the E.L.M.A. Handbook No. 2, the term "service illumination" is defined by implication as the average illumination over a given interval. It is also implied that the Maintenance Factor is the ratio of service illumination to initial illumination.

In B.S. 233:1953 Maintenance Factor is defined as: "The ratio of the average illumination maintained on the working plane at a given time and the average illumination obtained when the installation is first installed."

Here is confusion indeed! In the definition "service illumination" we have the average illumination *over a period*, whereas in the definition "Maintenance Factor" the average illumination is *over the illuminated area*. It is quite obvious that if we assume uniform illumination the B.S. definition of Maintenance Factor becomes simply the ratio—minimum : maximum illumination over the maintenance interval.

Which definition have we been using all this time? There is a school of thought which maintains that the matter is unimportant in view of the non-critical response of the eyes to variations in illumination, but lighting engineers must obey the rules of engineering; specifications must be worked to. If a service value of x lm/ft^2 is called for it is up to the engineer to provide it and if that engineer is working on behalf of an organisation which controls very large and/or multifarious lighting installations he is expected by his organisation to produce as nearly as possible the actual illumination specified. It is no use pointing out to his superiors that the difference between 10 lm/ft^2 and 12 lm/ft^2 is visually insignificant if they in their turn can point out that carelessness in exceeding the specified requirements is costing them many thousands of pounds for every lm/ft^2 added through inexactitude.

Lighting has been said to be as much an art as a science but we must not allow ourselves to be deceived by this statement. The art of lighting lies mainly in the prescription, but the engineering of the prescription requires a degree of precision which increases as the scale of operation increases.

I suggest that we should concern ourselves not with the average but with the minimum illumination received in service for this is the only true standard of performance. If, then, we adopt the convention that the service illumination is, in fact, the minimum illumination received in service (averaged, of course, over the *area* concerned), then the lighting engineer will know exactly where he stands as will his client or his employer, and the Maintenance Factor will at last mean something.

London. W. ROBINSON.

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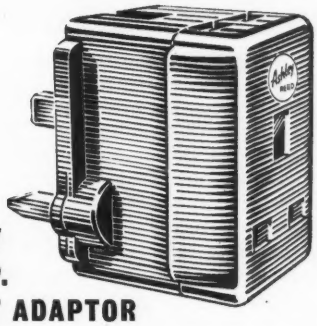

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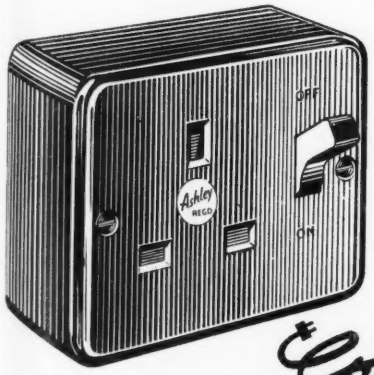

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LIGHTING INSTALLATIONS

Department store, Southampton

The main lighting at the new store of Tyrrell & Green Ltd., 136, Above Bar, Southampton, was specially designed by the G.E.C. Ltd. to the requirements of the owners, the John Lewis Partnership, to produce the ideal colour by which to display their wares. The colour chosen is a compromise between the effects of daylight and normal tungsten lighting.

A feature of the lighting installation are two modern chandeliers constructed of polished copper tube. Each chandelier carries 18 shades of opal glass housing 150-watt filament lamps. Specially designed to harmonise with the architectural design of the entrance, they are visible from the street and catch the eyes of window-gazing passers-by.

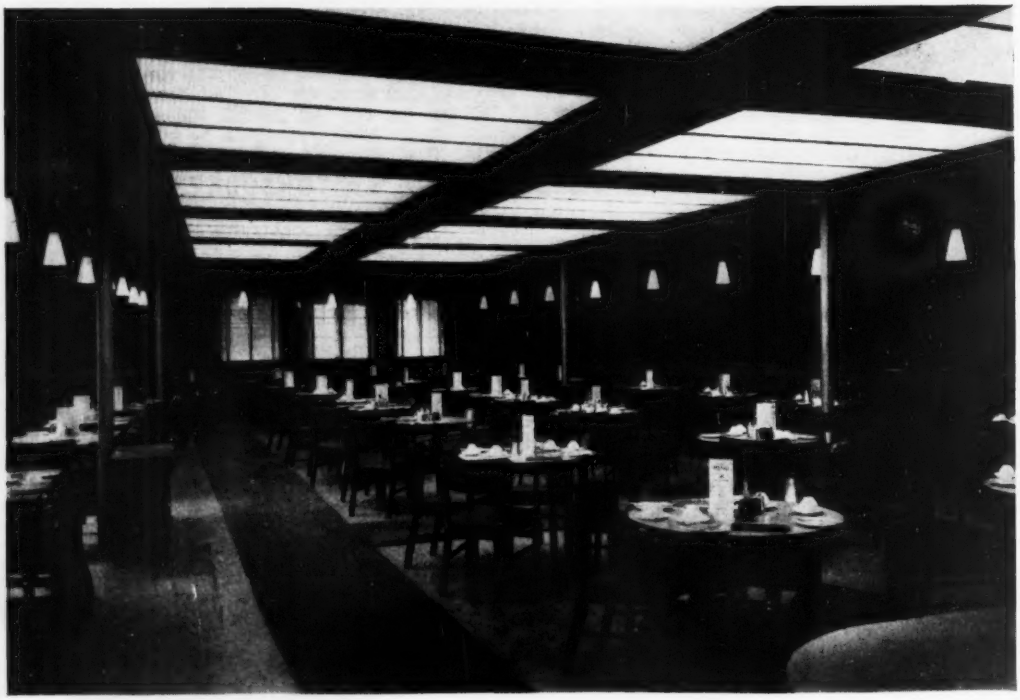
Cafeteria at Boots store, Leicester

An attractive new public restaurant has recently been opened by Boots Pure Drug Co. Ltd. at their premises in Gallowtree Gate, Leicester.

The modern decor is enhanced by the use of the Lumenated Ceiling lighting system, in which fluorescent lamps are fixed at true ceiling level above a false ceiling of corrugated translucent plastic. The installation comprises 10 panels, each consisting of three 3-ft.-wide strips of plastic, above which is a total of 360 ft. of cold cathode tubing in a plenum depth of 2 ft.

A 6-ft.-wide plastered surround extends the false ceiling to the walls. The Lumenated Ceiling panels are separated by 3-ft.-wide strips of hardboard placed 3 in. below existing ceiling beams. The fire-sprinkler system is incorporated in the hardboard panels.

The installation was under the direction of Mr. C. St. C. Oakes, M.B.E., F.R.I.B.A., Chief Architect of Boots Pure Drug Co. Ltd.



SHOWROOMS AND STORES

Deparment store, Southend

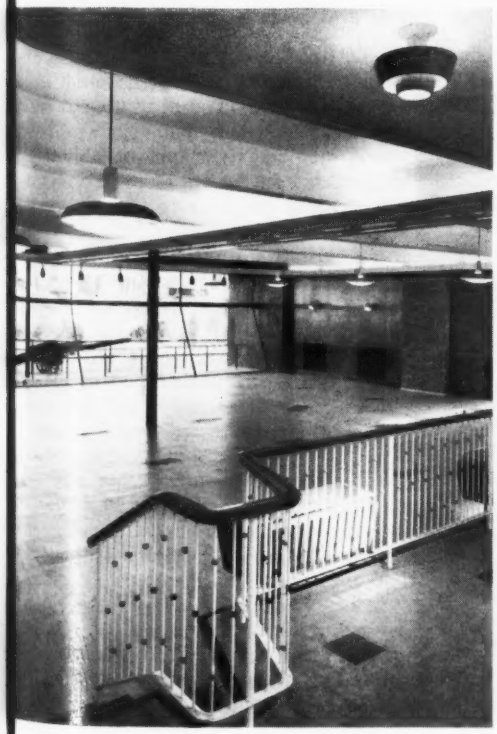
Keddie & Sons Ltd., of Southend, have installed new lighting in parts of their main premises and throughout a recently opened extension housing men's wear, millinery and other departments.

A lighting problem common to all stores, that of obtaining a suitable balance between general lighting and "emphasis" lighting, has been solved by using a combination of fluorescent and tungsten light sources. 75-watt and 150-watt reflector spotlights have been used to provide emphasis lighting, in either swivel mounted holders or housed in eyeball fittings recessed into the ceiling. Fluorescent fittings have been used for general lighting.

Fluorescent fittings in the extension include "Monolux" bare-lamp fittings, ceiling mounted and positioned to take advantage of ceiling beams which provide cut-off. Decorative fluorescent luminaires housing Deluxe Warm White lamps are suspended by conduit at a height of about 9 ft.

Illumination levels throughout the new extension vary between 10 and 15 lm/ft².

The lighting equipment was supplied by the B.T.H. Co. Ltd. and installed by Rayford Electrical of Southend.



Motor car showroom, Bradford

The recent opening of the Central Garage Limited Showrooms at Bradford has aroused considerable interest, particularly because it is the only new building erected in Bradford since the war.

Prominent among its many features is the lighting installation, which was carried out to the specification of the architect, W. Crossley Roff.

The car showroom contains two main schemes—one of indirect fluorescent lighting built into the beams and the second of louvred pendants with 500-watt lamps to provide the sparkle essential for satisfactory car display. Other luminaires in various colours are used. The layout has been arranged to provide good illumination levels and absence of glare.

The main lighting fittings were manufactured and supplied by Falk, Stadelmann & Co. Ltd., and the installation carried out by A. Higginbotham & Sons Ltd., of Bradford.

Lighting Notes from South Africa

A general review of lighting practice in the Union.

In which directions does lighting practice tend to develop in countries far removed from the main centres of lighting thought in Europe and America, particularly when in addition those countries import a large part of their lighting equipment? Does lighting practice in such countries show a particular "foreign" bias or do local tradition and design make themselves felt against the impact of imported styles and tastes?

The answers to these questions in respect of one such country, Japan, were given in a review of present-day Japanese lighting practice which recently appeared in this journal. There it was shown that many of the luminaires now being used in Japan combine typically Japanese designs executed in traditional materials with lighting gear imported from the United States or manufactured under licence from that country.

Another country which, as far as lighting is concerned, is somewhat similarly situated both geographically and industrially as Japan, is the Union of South Africa. Here is a country which is only just beginning to make a name for herself in the lighting field, a single instance being the development of the sector flux method of illumination calculation. Furthermore, here is a country which is only gradually increasing its capacity for manufacturing its own lighting equipment and which still relies heavily on imports from Holland, France and America, as well as from this country. The following review, compiled from notes supplied by Mr. J. V. Silverston of Johannesburg, may help to give a picture of lighting in South Africa to-day.

Inevitably it would be expected to find sharp contrasts in lighting techniques between one part of the Union and another. That such contrasts do not make themselves felt more strongly is probably due to the fact that the Union is itself a combination of contrasts, being influenced by Dutch traditions, American publicity and English tastes. All this is noticeable in the styles of architecture to be seen in the Union and the outlook on and method of approach to lighting problems.

It would be a mistake to consider the Transvaal, with Johannesburg as its centre, as being typical of South Africa as a whole. A more classical approach would be found in Cape Town. Port Elizabeth is a small Coventry while Durban, with its hotels, might be likened to a cross between Bournemouth and Brighton. Lighting practice in the Union is, therefore, likely to be as diverse as it is in the business cities, industrial towns and seaside resorts with which we are better acquainted. No one part of the Union can be taken as representative of the whole and consequently a general picture of current lighting practice in the Union cannot adequately be drawn.

A number of features of lighting practice, not altogether unfamiliar to lighting engineers in this country, do, however, seem to be fairly general throughout the Union. Cost is, for instance, a factor which is foremost in the mind of the average South African business man. On the other hand this is not allowed to be an over-riding factor and many examples could be quoted of lighting installations where expense has not dictated the method of approach. In fact, many public lighting installations in South Africa would be the pride of any municipality in the world. Speed also governs many lighting projects and this is particularly felt in the Transvaal. Buildings

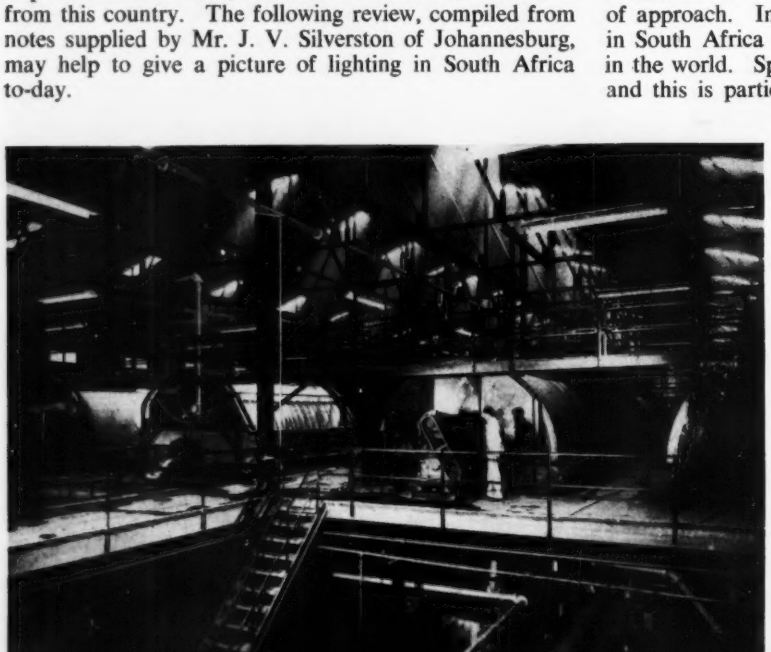


Fig. 1. Continuously operating cold cathode fluorescent installation at the Daggafontein uranium plant.

Fig. 2. Assembly line in a South African factory manufacturing luminaires for outdoor use.

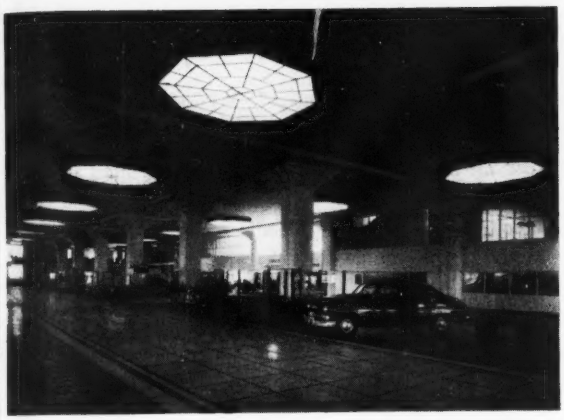


Fig. 3. Internally silvered reflector lamps and wide angle floodlights used to illuminate the exterior of Die Moederkerk at Bloemfontein, Orange Free State.

Fig. 4. A car showroom in Johannesburg illuminated by 25 13-ft. diameter luminaires, each luminaire housing 16 80-watt and 16 40-watt fluorescent lamps.

are often wanted in such a hurry that the lighting tends to be given only secondary consideration and consequently is dealt with at too late a stage in the building design.

The value of good lighting is only just beginning to be appreciated by architects and others in the Union. In fact the position is very similar to that which prevailed in this country just before the war, with the added disadvantage that many more light sources are now available to choose from. In general, architects and engineers are aware of the existence of specific developments in light sources and application techniques but are too pre-occupied with their own day-to-day problems to devote sufficient time to acquiring a proper understanding of these developments. As a consequence confusion arises in their minds when, for instance, a choice has to be made between the relative merits of the various types of hot and cold cathode fluorescent lamps. For all this, one is more likely to find industrialists who are willing to accept a new lighting technique than to find those taking a more cautious view by adhering to well-tried but possibly out-moded methods.

The ready availability in the Union of the lighting products of more than one importing country has resulted in a more open-minded approach to the products of individual countries. For instance, a four-tube ballast-operated cold-cathode fluorescent unit was found by experience to be particularly suited to South African conditions and consequently proves very popular there. For some time, though, it was necessary to import the lamps and control gear from the United States before complete units from this country became available.

The climatic conditions in the Union are such that large expanses of glass can be employed in building construction provided adequate protection from the sun is ensured. This lends itself readily to "contemporary" designs in architecture which have found great favour. This in turn has opened up a ready market for corresponding designs of luminaires, many finished in bright and arresting colours. In spite of this trend towards contemporary design there is, nevertheless, still a demand for classical designs of chandeliers and wall brackets, mostly in the Flemish style.

The photographs accompanying this review can in no way adequately demonstrate the diversity of lighting practice to be found in the Union. The description in an earlier copy of this journal of the recently installed lighting at Jan Smuts Airport, Johannesburg, is probably as eloquent an illustration as any of the fact that the relative geographical isolation of South Africa has in no way prevented that country from being in the forefront of lighting practice. The ambitious and highly successful floodlighting of the face of Table Mountain in connection with the national tercentenary celebrations in April, 1952, further confirms that lighting practice in South Africa can bear comparison with the best in other countries.

The recent acceptance of South Africa as a member of the Commission Internationale de l'Eclairage is evidence that an increasing interest in lighting matters is to be found in the Union and it is to be expected that by the time of the next C.I.E. meeting that country will be ready to take a major part in the international discussion of lighting problems.

Lighting Abstracts

OPTICS AND PHOTOMETRY

259. A preliminary study of reflected glare. 612.843.367

P. PETHERBRIDGE AND R. G. HOPKINSON, *Trans. Illum. Eng. Soc. (London)*, **20,** 255-7 (No. 8, 1955).

Describes a study into the factors giving rise to reflected glare, using B.R.S. glare formula to deduce glare discomfort from measured luminances and subtended solid angles of the reflected images, combined with direct appraisal. Results are given of studies on white and black glossy table tops. It is concluded that, apart from the disability effect, the discomfort associated with reflected glare is of less importance than the distraction, and consequent subjective irritation and dissatisfaction, which it causes. W. R.

612.843.7

260. Threshold of visual perception with more than one object in the field of view.

P. JAINSKI, *Lichttechnik*, **7,** 382-387 (*Oct.*, 1955). In *German.*

This paper, presented at the Zurich meeting of the CIE, describes experiments on the threshold of luminance for arrays of small discs viewed against backgrounds of different luminances. The number of discs was varied and for each number various arrangements with different separations between neighbouring discs were used. It was found that the threshold varied with this separation, and the results obtained in a number of typical cases are shown in a series of graphs. From these it is clear that there is always a value of separation at which the threshold is a minimum. In a second part of the work the threshold was determined for a series of rectangular patches, all of the same area but differing in shape. It was found that so long as the ratio of length to breadth did not exceed four the threshold was unchanged, but it increased progressively at greater ratios. J. W. T. W.

535.36 : 612.843.36 : 628.97

261. The visibility of light sources in fog.

J. OLIVIER; *Bull. Soc. Franç. Elect.*, *7th ser.*, **5,** 538-552 (*Aug.*, 1955). *In French.*

The geometry of a landing aircraft, the perception of lights by day and night, and the characteristics of diffusing atmospheres are outlined; it is established that fogs are non-selective. For a given value of "visibility" the fog density is much less by day than by night; consequently an increase of intensity of the lights has greater effect by day than by night. The colour of light signals is diluted by day, making them ineffective. By day the relation of oblique to horizontal visibility distances depends upon the brightness of the background and consequently upon the distribution of brightness in all directions around the observer suspended in the fog. Recent computations, with the assistance of electronic computers, have enabled these brightness distributions to be calculated for several cases, with diffuse illumination of the fog layer. The Duntley-Middleton approximate solution to the integration is found to be inapplicable and in serious error. It is concluded that horizontal and oblique visibility are substantially the same when : (a) the atmosphere is homogeneous; (b) the sun is obscured; (c) the upper surface of the fog layer is high in comparison wtih the height of the observer. J. M. W.

LAMPS AND FITTINGS

621.329 : 628.971.6

262. Lighting characteristics of street lighting fittings for fluorescent lamps.

A. WINDE, *Lichttechnik*, **7,** 387-388 (*Oct.*, 1955). *In German.*

Criticises certain conclusions reached by A. Pahl in a paper on the effect of temperature on the light output of fittings with fluorescent lamps [see *Light and Lighting*, Oct., 1955, p. 343]. There is a reply from this author. J. W. T. W.

621.327.43

263. Characteristics of power supplies for emergency fluorescent lighting.

A. B. TOLLEFSEN AND H. E. WEST, *Illum. Eng.*, **50,** 477-479 (*Oct.*, 1955).

Describes three circuits incorporating a vibrator power supply whereby fluorescent lamps up to 40-watt rating can, in an emergency or for special applications, be operated from low-voltage dry batteries or accumulators. Efficiencies ranging from 45 per cent. for 4 and 6-watt lamps to 70 per cent. for 15 and 30-watt lamps have been obtained. P. P.

628.94

264. Efficiency values and polar curves for fluorescent lamp luminaires.

A. PAHL, *Lichttechnik*, **7,** 340-342 (*Sept.*, 1955). *In German.*

Fittings are divided into two classes, open and enclosed. The former may be used near the ceiling or suspended at some distance from it, when the efficiency is higher, viz. 82 to 89 per cent, as compared with 62 to 77 per cent. For enclosed fittings the effect of temperature is important and figures are given for various fittings, enclosing from one to three lamps, for room temperatures ranging from 0 to 40 deg. C. The maximum efficiency usually occurs at about 10 to 12 deg. C. Some figures are also given for fittings used for the corner mounting of fluorescent lamps. The paper includes polar curves of light distribution for certain fittings. J. W. T. W.

621.327.43

265. Regulation by transductor and by electronic devices.

H. SCHAAL, *Lichttechnik*, **7,** 342-348 (*Sept.*, 1955). *In German.*

A description of the various methods which can be used to regulate the light output from fluorescent lamps, *viz.* resistive, inductive, capacitive, by transistor or by electronic devices, is followed by a comparison of their respective

advantages and disadvantages. The electronic regulator and transductor regulator are described in considerable detail, with circuit diagrams, special reference being made to their use in stage lighting control. A combination of electronic and transductor methods is foreshadowed. J. W. T. W.

LIGHTING

266. Electroluminescence. 621.327: 535.37

J. N. BOWTELL and H. C. BATE, *Trans. Illum. Eng. Soc. (London)*, **20**, 223-236 (No. 7, 1955).

Describes the construction of electroluminescent devices as developed from the early work of Destriau to the present day, including one using a standard filament lamp bulb and cap. The mechanism of electroluminescence is discussed, the operating characteristics described and some applications are given. It is pointed out that considerable further development is required before electroluminescence can be ranked as a light source comparable with present conventional lamps. W. R.

267. Economics of classroom lighting. 628.972

ROBERT L. ZAHOUR, *Electrical Construction and Maintenance*, **54**, 77-81 (*July*, 1955).

Considers eight lighting layouts for classrooms based on the recommendations of the A.S.A. American Standard Practice for School Lighting with notes on the applicability and special features of each layout. A detailed tabular cost analysis is given for nine lighting systems (not related to those previously discussed), each being based on a different type of light source. W. R.

628.972

268. New orientation of research in lighting technique.

S. HESSELGRENI, *Ljuskultur*, **27**, 63-65 (*July-Sept.*, 1955). *In Swedish.*

The need is emphasised for the lighting engineer to study the science of perceptions. The article summarises some preliminary principles which the author considers of fundamental importance. R. G. H.

628.972

269. Modern lighting installations in large offices and department stores.

L. C. KALFF, *Ljuskultur*, **27**, 68-70 (*July-Sept.*, 1955). *In Swedish.*

Efficiency in human affairs demands a good environment for work, and good lighting is one feature of a good environment. The application of the author's principles to the lighting of a 500-person office is described. R. G. H.

270. New lighting installations in Berlin. 628.972

R. STAEGER, *Ljuskultur*, **27**, 71-75 (*July-Sept.*, 1955). *In Swedish.*

Describes installations in the new concert hall of the College of Music in Berlin, and in a library, a reading room, a sports hall and boxing ring. Photographs of the installations and diagrams of the equipment are given. R. G. H.

271. Floodlighting of Drottningholm Palace. 628.971

Ljuskultur, **27**, 76 (*July-Sept.*, 1955). *In Swedish.*

Describes, with photographs, the floodlighting installation recently erected at the Drottningholm Palace. The floodlights can be recessed when not in use into small manholes on the terrace. R. G. H.

272. Economics of lighting maintenance. 628.972

M. E. HASKINS, JUN., *Electrical Construction and Maintenance*, **54**, 102-106 (*Sept.*, 1955).

Discusses the economics of group versus random lamp replacement and gives formulae for determining the most economical method, for different circumstances. The economics of fittings cleaning are also considered and a formula given for calculating the most economical cleaning interval. W. R.

273. Methods for lighting pictures in residences. 628.972

E. FREYER, *Illum. Engng.*, **50**, 487-502 (*Oct.*, 1955).

Descriptions and photographs are given of methods for lighting pictures in the home by means of picture-attached lights, lighted frames, floodlights, spotlights, optical projectors and wall lighting. Comments are made on the direction and colour of the light, the illumination level and the avoidance of reflected glare. A table gives operating characteristics of 25 picture-lighting units, including the distribution of illumination over an area 40 in. by 28 in. P. P.

628.92

274. Daylight measurements in six New England schools.

W. ALLPHIN, *Illum. Engng.*, **50**, 462-470 (*Oct.*, 1955).

Reports daylight measurements made over a one-year period in six New England schools having different form of fenestration. Hourly readings of the illumination midway from front to rear walls of the classrooms showed levels in excess of 100 lm/ft² on 11 per cent. of all occasions and of 10 lm/ft² or less on 7 per cent. of all occasions. The study concludes that in climates similar to or darker than central New England the artificial lighting should be designed for a minimum illumination of not less than that (30 lm/ft²) recommended by the American Standard Practice for School Lighting. P. P.

628.971

275. The floodlighting of historical buildings and "Sound and Light" spectacles in France.

JEAN J. CHAPPAT, *Trans. Illum. Eng. Soc. (London)*, **20**, 243-254 (No. 8, 1955).

Outlines the history of the floodlighting of historic buildings in France and describes the technique being used in the creation of Light and Sound spectacles. The Infranor projector, on which most of the installations are based, is described and its value in producing delicate colour effects noted. Methods of controlling light and colour effects are described with particular reference to the chromoselector. The sound effects technique is briefly discussed. The author points out the essentially aesthetic nature of the spectacles and the necessity for close team working. He expresses the view that these spectacles are by no means a passing craze but that they will continue with steady improvements for many years ahead. W. R.

276. Hospital design with a future. 628.972

G. C. SCHROEDER, JR., *Illum. Engng.*, **50**, 521-523 (*Nov.*, 1955).

Describes the lighting of the Crippled Children's Hospital, New Orleans, which received first prize in the United States National competition for "My most interesting lighting job." Nursing areas are lit by fluorescent units having a switching arrangement to give 1 lm/ft² for night lighting. General ward lighting is indirect and is provided by twin fluorescent lamps built into the top of each patient's bed unit. Ceiling luminances between 10 and 50 ft.L produce an average illumination of 10 lm/ft². An additional tungsten lamp in each bed unit gives 50 lm/ft² at the bed head. P. P.

I.E.S. ACTIVITIES

London

At the sessional meeting held in London on January 10 a paper entitled "Recent developments in photometry and colorimetry" was presented by Mr. G. T. Winch.

At the beginning Mr. Winch referred to recent developments in secondary standard lamps, both tungsten filament and tubular fluorescent types, because of the important part which they play in accurate photometry and colorimetry. A summary of recent informal international photometric and colorimetric inter-comparisons showed a promising measure of agreement.

The validity of the C.I.E. Standard Observer data has been questioned by several workers and reference was made to Stiles's recent redetermination of the colour mixture data, from which it seems possible that recommendations might arise for revision of the present C.I.E. data. The possible repercussions of such changes on photometric levels was indicated.

Developments in physical photometry have greatly improved accuracy and speed of measurement. The dispersion and mask method of achieving any desired overall spectral response has made possible the practical realisation of one photoelectric instrument which may be used as both a photometer and colorimeter. By this means high accuracies have been achieved.

Improvements in the accuracy of radiometry make it seem possible that in the foreseeable future, in the standardising laboratory, indirect photometry and colorimetry may be carried out by this means and thus avoid the need for reference to the primary standard of light.

In connection with the realisation of greater uniformity of colour and colour rendering of fluorescent lamps, and practical means of measuring and specifying these characteristics, there is a need for further improvements in accuracy and speed of photometric and colorimetric measurements. This ultimately necessitates greater sensitivity, and to this end investigations in hand indicate the possible improvements which may result from the use of photomultiplier photocells. Preliminary results indicate that recently available photomultipliers having cathodes of suitable spectral response may give an improved accuracy using conventional d.c. amplification, particularly if liquid air is used to cool the photomultiplier and so reduce dark current.

A still more interesting investigation referred to by the author is one in which the electrons are counted due to photons, i.e., the quanta of visible radiation incident on the photocathode. Whilst there are many difficulties associated with this technique some promising preliminary results were indicated. It seems likely that by applying this technique to the dispersion and mask method of photometry and colorimetry an overall increase in accuracy and speed of operation may result. An added attraction is that the answer is indicated directly in figures and by the addition of a relay mechanism it should be possible to print the results on a record sheet.

When it is required to measure the average colour of light from tubular fluorescent lamps it is convenient to operate them in a photometric integrator and to measure the luminous flux and average chromaticity by observing the integrator window, using suitable apparatus. Whilst no serious *photometric* errors arise due to small departures from neutrality of the white integrator paint, serious *colorimetric* errors can arise from this cause. For this reason investigations have been carried out on new and more neutral paints which give promise of reducing errors from the above indicated causes.

In connection with colour-rendering properties of light sources and *objective* measurements related to their *subjective* characteristics, reference was made to possible changes in the wave-length intervals of the C.I.E. eight spectral bands, the relative luminance in which is used in making objective measurements related to colour-rendering properties.

In conclusion, Mr. Winch said that, in addition to the possible further development and application of photon-counting techniques, ultrasonic wave gratings might be used as colour modulators or monochromators controlled electronically.

Birmingham Centre

A sessional meeting of the Birmingham Centre took place on November 25, when a paper on "Germicidal radiation" was read by Mr. D. H. Holloway.

Mr. Holloway commenced his lecture by describing briefly the problems attendant on the manufacture of suitable lamps to provide u.v. radiation in a wave band which would effectively destroy or render harmless bacteria, virus and harmful yeasts. A wave-length of 2,537 Angstrom units was found to be most effective and a special glass had been developed making it possible to produce lamps which could be marketed at a reasonable price. This glass had the advantage of preventing the radiation of the very short wave-lengths also produced within the lamp, which if radiated would produce ozone in undesirable quantities.

Mr. Holloway then described the many applications of the equipment using slides to illustrate typical installations. The prevention of mould and bacterial growth on foods was fully described and illustrated. The lamps installed on machinery for the packing of medicaments was then dealt with, an installation on a machine for packing penicillin being shown. Sterilisation of the air in a hospital operating theatre enabling the surgeon and staff to work without face masks illustrated another application.

The many and varied situations in which the equipment would perform its silent task of freeing the atmosphere of invisible disease and possible death were obvious to everyone who attended the lecture, and if the high standard and number of questions which followed could be taken as a guide to the response of the audience to a new subject the lecturer had no need of the vote of thanks which followed.

The Annual Dinner of the Birmingham Centre was held at the Queens Hotel, Birmingham, on Friday, January 13, when there was an attendance of 170 members and guests. The Centre was honoured on this occasion by the presence of The Lord Mayor of Birmingham (Alderman A. Lummis Gibson), who proposed the toast of "The Illuminating Engineering Society." The response to this toast was made by Dr. J. W. Strange, a Vice-President of the Society. The toast of "Our Guests" was proposed by the Chairman, Mr. G. R. Hanson, who made reference to the special guests present. Dr. R. Beeching (Chairman of the Metals Division of Imperial Chemical Industries, Ltd.) responded to this toast in a most adequate manner.

Opportunity was taken at this meeting to make a presentation to Mr. W. J. P. Watson, who retired as Hon. Secretary of the Centre on December 31. Although the wing-chair, which Mr. Watson had chosen as the gift he would like, was not available, he was presented with a generous cheque from members of the Centre by the Chairman. Mr. Watson, in an impromptu speech of acceptance of this gift, thanked all the members for their kindness and also for the co-operation he had received during the last ten years.

Nottingham Centre

The Nottingham Centre had a large gathering of members and friends at their meeting on December 1 to hear a lecture given by Mr. Mills, Mr. Bellchambers and Mr. Arnold, who presented a lecture on "Lighting as an effective aid to architecture." The lecture was supported by a large amount of apparatus and demonstration models, and from the numerous questions which followed it was obvious that the audience had been absorbed in the subject matter.

At the meeting in Nottingham on January 5 the Chairman, in opening the meeting, said the occasion was a unique one in that Dr. Roberts, Mr. Slater and Mr. Small, who were to give their impressions of the 1955 C.I.E. Meeting, were all past chairmen. Dr. Roberts opened by giving a brief survey of the aims and objects of the C.I.E. and a description of the city of Zürich. He was followed by Mr. Slater who referred to the differences in contractual work in Switzerland as compared with Great Britain and also showed those present a number of switches, joint boxes,

etc., which he had brought home. Mr. Small followed and gave a resumé of the Secretariat Reports which had been presented on street lighting, floodlighting, advertising signs, etc., and concluded his remarks by showing a number of lantern slides. Dr. Roberts summed up by giving details of the resolutions passed at the meeting. This was followed by an informal discussion between the three participants in which the audience joined. A formal vote of thanks to the three speakers was moved by the Chairman, Mr. P. A. Moore, and received with acclamation.

Sheffield Centre

The Sheffield Centre held their third sessional meeting on December 12, at the Sheffield University, Western Bank. Dr. F. A. Benson took the chair in the absence of the Centre chairman.

On this occasion four members of the Centre gave short papers. Mr. J. Gilbert opened the evening with a paper on "Public lighting administration," dealing with the work of a public lighting engineer, and giving brief details of the design, maintenance and, above all, the economic limitations that control the development of municipal lighting schemes. During the discussion Mr. Gilbert stated that in his experience group replacement of lamps was certainly more economical than replacement after "burn out."

Mr. V. Loupart, the title of whose paper was "Local research on road safety lighting," gave a talk on his research into road vehicle lighting problems, including the reduction of dazzle compatible with safe driving at fairly high speeds. Much of his work showed an original approach to the safe use of road lamps.

Mr. F. Smith, whose subject was "A problem in colour matching," then discussed the problems of colour matching in industry, with particular reference to difficulties experienced when fluorescent bleaches are used in processing. He said that the deficiency of u.v. radiation in most artificial light sources was the root of the trouble, and explained in detail steps which had been taken to successfully overcome this difficulty in a particular installation.

Mr. J. A. Whitaker, who was the fourth speaker, gave an interesting talk on the floodlighting installation at the Sheffield Wednesday football ground. The notable features of the installation include: (a) six towers, (b) absence of projector lamps, (c) avoidance of peak focus at the beam centre even in the narrowest settings used, and (d) sighting in daylight without any subsequent adjustment. The first three features contribute very largely to the overall comfort conditions for spectators and players alike. The discussion endorsed the unique character of the installation and the general approval with which it is viewed in the Sheffield district.

Transvaal Centre

A meeting of the Transvaal Centre was held on Wednesday, November 23, at which a paper on "Home lighting" was read by Mr. Yates. The meeting was well attended and included in the audience were members of the Housewives' League of South Africa. The lecture was followed by a brisk discussion, the main topic of which dealt with various views on the use of fluorescent lighting in the home.

On January 25 members of the Centre were taken on a conducted tour of the Jan Smuts Airport, the lighting of which has been planned to provide facilities equal to those of any other airport in the world. In addition to the control tower and airfield installations, arrangements were made to study the workshop, sub-station and stand-by lighting.

FORTHCOMING EVENTS

LONDON

February 14

Sessional Meeting. "Lighting at London Airport," by J. G. Holmes. (At the Lighting Service Bureau, 2, Savoy Hill, London, W.C.2.) 6 p.m.

February 28

Lecture. "Lighting Aids for Marine Navigation," by K. Sutton-Jones. (At the Lighting Service Bureau, 2, Savoy Hill, London, W.C.2.) 6 p.m.

CENTRES AND GROUPS

February 1

EDINBURGH.—"Progress in Lamps and Lighting," by H. R. Ruff and R. V. Mills. (At the Y.M.C.A. Small Hall, 4, Queen Street, Edinburgh.) 6.15 p.m.

NEWCASTLE.—"Use of Lighting in Horticulture," by D. H. Holloway. (At the Large Lecture Theatre, Grey Hall, Department of Electrical Engineering, King's College, College Road, Newcastle-upon-Tyne, 1.) 6.15 p.m.

SWANSEA.—"Black Light, its Effect and Applications," by H. L. Privett. (At the South Wales Electricity Board's Demonstration Theatre, The Kingsway, Swansea.) 6.30 p.m.

February 2

CARDIFF.—"Black Light, its Effect and Applications," by H. L. Privett. (At the South Wales Electricity Board's Demonstration Theatre, The Hayes, Cardiff.) 5.45 p.m.

GLASGOW.—"Progress in Lamps and Lighting," by H. R. Ruff and R. V. Mills. (At the Institute of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, C.2.) 6.30 p.m.

NOTTINGHAM.—"The History of Mine Lamps," by Miss H. M. Maurice. (At the Demonstration Theatre of the East Midlands Electricity Board, Smithy Row, Nottingham.) 6 p.m.

February 3

SWANSEA.—Annual Dinner Dance.

February 7

STOKE-ON-TRENT.—"Hospital Lighting," by M. W. Pierce. (At the Lecture Hall of the Midlands Electricity Board, 31, Kingsway, Stoke-on-Trent.) 6 p.m.

February 13

LEEDS.—"Cold Cathode Lighting," by G. Robinson and A. E. Fothergill. (At the Lecture Theatre of the Yorkshire Electricity Board, Ferensway, Hull.) 7 p.m.

SHEFFIELD.—"Photometric and Other Tests for Street Lighting," by W. A. Varney. (At the Medical Library, The University, Western Bank, Sheffield, 10.) 6.30 p.m.

February 15

NORTH LANCASHIRE.—"Recent Work on Discomfort Glare," by R. G. Hopkinson and P. Petherbridge. (At the Demonstration Theatre of the North Western Electricity Board, 19, Friargate, Preston.) 7.15 p.m.

TEES-SIDE.—"Prescribing for Seeing," by M. L. Berson. (At the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough.) 6.30 p.m.

February 16

MANCHESTER.—"Recent Work on Discharge Glare," by R. G. Hopkinson and P. Pethebridge. (At the Demonstration Theatre of the North-Western Electricity Board, Town Hall Extension, Manchester.) 6 p.m.

February 21

GLOUCESTER AND CHELTENHAM.—"Lighting for Decoration," by A. E. Hurst. (At the Fleece Hotel, High Street, Cheltenham.) 6.30 p.m.

LIVERPOOL.—"The Effect of the Lighting Load," by W. B. Parkinson. (At the Liverpool Engineering Society, 9, The Temple, Dale Street, Liverpool.) 6 p.m.

February 23

GLASGOW.—Informal Dinner Dance.

February 24

BATH AND BRISTOL.—"Black Light," by R. V. Mills. (At the Royal Hotel, Bristol.) 7 p.m.

BIRMINGHAM.—Annual General Meeting. Address by A. G. Penny (Vice-President). (At "Regent House," St. Phillip's Place, Colmore Row, Birmingham.) 6 p.m.

February 27

LEEDS.—"A Brief Résumé of the History and Development of Mine Lamps," by Miss H. M. Maurice. (At the E.L.M.A. Lighting Service Bureau, 24, Aire Street, Leeds, 1.) 6.15 p.m.

LEICESTER.—"Lighting for Decoration," by A. E. Hurst. (At the Demonstration Theatre of the East Midlands Electricity Board, Charles Street, Leicester.) 6 p.m.

NEW PRODUCTS

80-watt fluorescent pack

The first combined fluorescent pack to be marketed by The General Electric Co., Ltd., became available on January 2. Known as the Osram "One-Eighty," the pack will consist of a channel fitting, wired with switch-start control gear for 200-volt to 250-volt 50 cycles supply, and an 80-watt 'New Warm White' fluorescent lamp. The fitting is of an entirely new design, the main feature of which is its easy method of fixing, without the use of loose screws, chains or wires. It is finished in high quality white stove enamel which contains rust inhibitor. The price, complete, is £4 19s. 9d. (tax paid).

Lamp for film production

The largest tungsten filament lamp made in the country has been manufactured by The British Thomson-Houston Company, Ltd., at a research and development cost of over £10,000. Designed for film studio lighting, the new 20-kw. lamp will be used in making colour films. The Mazda 2- and 5-kw. lamps were developed before the war, but the 5-kw. lamp, for example, had an effective life of only 25 hours. After the war the demand arose for increasingly powerful light sources and B.T.H., in collaboration with film studios, developed a series of lamps for colour photography with the ultimate object of keylighting a whole film studio set from one light source. A 10-kw. lamp was successfully built, for which there has been a very large demand. The B.T.H. company's glass works at Chesterfield achieved a triumph of bulb manufacture with the 15-in. diameter boro-silicate bulb for this latest 20-kw. lamp. It is of uniform thickness to minimise fracture strain, and weighs 10 lb., while the filament contains sufficient tungsten to make 20,000 40-watt household lamps. Its 50,000 mean spherical candle power is approximately 1,600 times that of a 40-watt bulb.

Reflector Fluorescent Lamp

Several lamp firms announce the introduction of a new 4-ft. reflector fluorescent lamp. The reflecting surface of the lamp consists of an independent layer of powdered titanium dioxide bonded to the internal surface of the lamp and applied in much the same way as a fluorescent coating. This material, which has a high reflection factor, is applied internally to the upper surface of the lamp and extends over two-thirds of the circumference, with the result that most of the light generated throughout the fluorescent surface is directed downwards through the gap in the reflector. When these lamps are used in fittings having little or no directional light control, they give nearly twice as much light on the working plane as compared with the conventional 4-ft. lamp. At present the lamp is manufactured by the G.E.C., Ltd., and B.T.H. Co., Ltd., in the daylight colour, and by Philips Electrical, Ltd., in cool white. The lamp retails at 13s. 9d., plus purchase tax.

Trade Notes

Improved performance for Osram 250- and 400-watt mercury lamps used for streetlighting is announced by The General Electric Co., Ltd. Increased figures for the average efficiency have been achieved as a result of recent research and development work. Average light output throughout the life of the 400-watt mercury lamp has been increased by 14.7 per cent., from 13,600 to 15,600 lumens. For the 250-watt lamp the increase is 13 per cent., from 7,750 to 8,750 lumens.

Similar improvements are also announced for the Mazda mercury lamps up to the 1-kw. MA/H lamp, the output of which is increased from 40,000 to 43,000 lumens.

A miniature stage, suitable for demonstrations of modern lighting, is one of many interesting features of the new Midland Area Showrooms of Thorn Electrical Industries, Ltd.'s Atlas Lighting Division. These premises at 24, Sheepcote-street, Birmingham, provide facilities for showing Atlas products in contemporary surroundings and are equipped to demonstrate electronically controlled fluorescent colour lighting. Another feature is a colour-comparator, each section large enough to be dressed as a shop window, which can be used to demonstrate the effects of different light sources and colours on food, fabrics and other merchandise. The company has also opened a new showroom at 9, Stevenson-square, Manchester.

Trade Literature

THE SUN ELECTRICAL CO., LTD., 118-124, Charing Cross Road, London, W.C.2.—Well illustrated "Crystex" catalogue giving full details of a wide range of contemporary domestic fittings, including prices.

LINOLITE LTD., 118, Baker Street, London, W.1.—Leaflet 23A giving full details and prices of the latest electric light fittings, strip reflectors and signs.

CRYSELCO, LTD., Kempston Works, Bedford.—Leaflet introducing a new 5-ft. slimline channel fitting giving details and prices. Also a leaflet giving details of the Edison screw heat resisting lamp-holder and a polished aluminium clip-on reflector.

PHILIPS ELECTRICAL LTD., Century House, Shaftesbury Avenue, London, W.C.2.—A thirty-two page brochure entitled "Careers in Philips" dealing with technical and commercial opportunities open to graduates and others seeking employment with this company, including scope in lighting, industry, medicine, entertainment,, etc.

THE BRITISH THOMSON-HOUSTON CO. LTD., Crown House, Aldwych, London, W.C.2.—New lamp catalogue giving full details, illustrations and prices of lamps, including decorative, infra-red, neon, fluorescent and electric discharge, projector and photographic, car bulbs and miniature lamps.

EVANS ELECTROSELENIUM LTD., Harlow, Essex.—Leaflet L.125, illustrating the "EEL" B.R.S. daylight factor meter, including details on construction, operation and application.

THE GENERAL ELECTRIC CO. LTD., Magnet House, Kingsway, London, W.C.2.—New publication, giving full details on high-intensity lighting for shop windows with Gecoray reflectors.

THE EDISON SWAN ELECTRIC CO., LTD., 155, Charing Cross Road, London, W.C.2.—New catalogue containing complete details and prices of the full range of electrical accessories for domestic, commercial and industrial installations including several recently introduced items.

Personal

The General Electric Company, Ltd., announces that MR. D. A. STRACHAN, A.I.Min.E., F.I.E.S., has been appointed to the Head Office of the Company and will be responsible for Flameproof and Mining Equipment Sales. Mr. Strachan for the past seven years has been Lighting Engineer at the London Headquarters of the National Coal Board. Before joining the N.C.B. he was with Metropolitan-Vickers Electrical Co. at their Newcastle and London Offices. He is a Council member of the Illuminating Engineering Society and the London Branch of the Mining Electrical and Mechanical Engineers. Mr. Strachan has presented a number of Papers dealing with the application and design of flameproof and other lighting equipment for use in hazardous locations, both here and overseas. For the past five years he has been Chairman of the Mine Lighting Sub-Committee of the National Illumination Committee.

MR. F. WIDNALL, B.Sc., M.I.E.E., B.T.H. Lighting Engineer, has been appointed Manager of the Company's Lighting Fittings Factory at Hereford. After serving an

engineering apprenticeship with B.T.H. Mr. Widnall spent nine years in the Research Laboratory before joining Lighting Equipment Engineers in 1939. He was appointed Head of Lighting Equipment Engineering Dept. in 1950—the position he holds at present. Mr. Widnall is a member of the Illuminating Engineering Society and of the Association of Mining Electrical and Mechanical Engineers.

The resignation of SIR EDWARD C. BULLARD, SC.D., F.R.S., from the Directorship of the National Physical Laboratory took effect on December 31, 1955. The appointment of a successor to Sir Edward Bullard will be announced in due course. In the meantime, and pending the taking up of office by a new Director, the Lord President of the Council has appointed DR. R. L. SMITH-ROSE, C.B.E., D.SC., M.I.E.E., Director of Radio Research in the Department of Scientific and Industrial Research, to be Acting Director, with effect from January 1, 1956.

The following two students attending the Northampton Polytechnic's Illuminating Engineering Courses during the Session 1954-5 are to be congratulated on being awarded the City and Guilds of London Institute's first prizes in Illuminating Engineering:—M. F. OLDHAM who was awarded the Institute's Bronze Medal for the First Prize for the Intermediate Examination, and J. H. HOWARD who was awarded the Institute's Silver Medal for the First Prize for the Final Examination.

Sangamo Weston Limited, Enfield, Middlesex, announce that MR. S. BAXTER-JONES has been appointed area manager of the company's north eastern area, based at Milburn House, Newcastle-upon-Tyne. The new appointment took effect from January 12.

Philips Electrical Ltd. announce the appointment of MR. A. L. SUTHERLAND and MR. H. C. WHITE as directors of the company. Mr. Sutherland joined Philips in 1933 as lamp representative for West London, becoming lamp sales supervisor in 1937. In July, 1938, he was promoted head of the special lamps department in which post he served until joining the Army in 1940. Upon rejoining Philips in May, 1946, he managed the tungsten lamp department until being appointed commercial manager of the television and radio division in January, 1950.

Mr. White began his career with the company in 1929 as a representative in the West Riding of Yorkshire. He was promoted area supervisor, attached to head office, in 1934 and in 1940 returned to the north of England as manager of the Manchester branch (now the North West Region). In 1949 he came back to London as commercial manager of the lighting division.

Situations

Vacant

Philips Electrical Ltd. has vacancies for LIGHTING SALES REPRESENTATIVES and SALES ORDER CLERKS based in London. Representatives should have experience of the full range of lighting products including fittings and be prepared to cover territories in London and the southern counties. Minimum salary £620 p.a. Order Clerks should be young men between 20 and 25 with some knowledge of sales routine and correspondence. Experience in the production of lighting fittings would be an added qualification. Minimum salary at 25 years of age £9 3s. 6d. per week. Applications for the above positions, giving details of age and experience, should be addressed to the Personnel Officer, Century House, Shaftesbury Avenue, London, W.C.2. Quote Ref. 792.

LIGHTING SALES ENGINEER required to cover Leicester, Coventry and Northampton territories. Applicants should have illuminating Engineering and Sales experience and in addition a knowledge of, and in connection with, basic industries in those territories. Applications giving details of age, qualifications, experience and salary required to The General Sales Manager, The Benjamin Electric, Ltd., Brantwood Road, Tottenham, London, N.17.

A LENS DESIGNER might think he had no place with a motor manufacturer. He would be wrong. He could have a future with Ford. His pay would increase with his merits, his future would be secured by a free pension, and his work might, if he is good enough, make a worthy contribution to road safety. Might you be the man? Your technical knowledge must comprise all lens requirements, photometrics, tests, materials and finishes. If you can offer these, we shall be glad to hear from you. Our address is Salaried Personnel Department, Ford Motor Co., Ltd., Dagenham, Essex. Please quote reference VCL/5.

TECHNICAL ASSISTANT (age 24-30) required to carry out inspection of cinema premises and to report on condition of lighting and power installations and to prepare specifications. Apply Box No. 911.

Miscellany

The Design Centre

It is announced that the Duke of Edinburgh will open "The Design Centre for British Industries" at 28, Haymarket, S.W.1, on the afternoon of Thursday, April 26. The Design Centre, organised by The Council of Industrial Design, will be a permanent national exhibition of well-designed durable consumer goods, and the first of its kind in the world. From Friday, April 27, onwards, this national showroom, with its constantly changing selection of well-designed things in current production in Britain, will be open on week-days (including Saturdays) from 9.30 a.m. to 5.30 p.m. Admission will be free.

Exterior Lighting Exhibition

A new exhibition dealing with a wide variety of exterior lighting opened at the Mazda Lighting Showroom, Crown House, Aldwych, London, on Monday, January 2. Street lighting and the lighting of docks, shipyards, railway stations, goods sidings and the floodlighting of buildings and sport all have a place.

Street lighting has been given the greatest prominence because directly or indirectly it is vitally important to the entire community. The street lighting exhibit includes a traffic accident graph and sections dealing with current street lighting techniques and the latest lanterns, control gear and columns. A separate display deals with the production of sodium discharge lamps which are used extensively for street lighting and the latest integral jacket sodium lamps.

The exhibit on railway siding lighting deals principally with the latest form of high tower floodlighting developed by B.T.H. for railway sidings. It is illustrated with a diorama and photographs of the installation at Lackenby Steelworks.

British Electrical Power Convention

"Electricity and Transport" will be the theme of the eighth British Electrical Power Convention which is to be held at Torquay immediately after the Whitsun holidays, under the Presidency of Sir John Dalton, Chairman, W. T. Henley's Telegraph Works Co., Ltd. The biggest-ever Electrical Convention Exhibition will occupy 30,000 sq. ft. of the Torre Abbey Meadows and will be officially opened by Sir John Dalton on the evening of Wednesday, May 23.

The Convention will be opened on Thursday, May 24, by a Civic welcome from the Mayor of Torquay, followed by the Presidential address. Papers on various aspects of electricity and transport will be given on May 25, 26 and 28. The only paper not dealing with this subject is one entitled "The electric house," which is to be given on the Monday morning by Mr. D. Bellamy, Chairman of the Yorkshire Electricity Board. This paper will be supported by a three-bedroom bungalow which is to be erected near the exhibition and which will contain up-to-date electrical equipment and appliances.

The Convention Dinner will be held on the Monday evening at the Palace Hotel followed by a dance at the Town Hall. The concluding session will take place on the Tuesday morning.

POSTSCRIPT By "Lumeritas"

WHAT is the meaning and use of the "maintenance factor"? Well, you say, what a simple question! Every student lighting engineer should be able to answer that one and, if he can't, he shouldn't complain if he is "ploughed" at his first exam. Yet, as Willard Allphin—an experienced American lighting engineer—has pointed out on several recent occasions, the maintenance factor is used in lighting calculations apparently with no very clear idea of what it means. Moreover, I believe that some equally experienced lighting engineers on this side of the Atlantic would have difficulty in saying just what they have in mind when they use it.

According to B.S.233 : 1953, the maintenance factor is "The ratio of the average illumination maintained on the working plane at a given time to the average illumination obtained when the installation is first installed." So, if the "given time" is one hour after installation the maintenance factor is very likely to be unity. But, if the given time is three months or twelve months after installation, the maintenance factor may well be something like 0.8 or 0.6. Now, when we choose a given maintenance factor—say, 0.8—for the purpose of installation design, do we assume that the average illumination on the working plane will be maintained at not less than 80 per cent. of the new installation value or, alternatively, that the average illumination on the working plane will be maintained "on the average" at 80 per cent. of the new installation value? If we make the first of these assumptions then the I.E.S. Code value for which we have designed will, "on the average," be exceeded in service, but, on the second assumption, the average illumination on the working plane will vary at different periods in service between 1.25 and 0.75 times the Code value.

It may not matter very much if the illumination in service does range between the limits taken in the above example. Although I.E.S. Code values are appropriate design targets they are, of course, qualified by tolerances. An excess of 25 per cent. makes seeing a little better and a "shortfall" of 20 per cent. does not make it very much more difficult. Nevertheless, unless "realistic" maintenance factors are used, the assumption that they indicate what the service illumination is expected to be "on the average" carries implications of possibly absurd situations. Thus, Allphin has pointed out that the use of a maintenance factor of 0.5 would mean that, while the initial illumination value would be double the average maintained value, the illumination would fall to zero before actual maintenance was done. With a maintenance factor lower than 0.5 the lowest illumination reached in service would, theoretically, be a minus quantity! Allphin suggests that design calculations should be based on the minimum illumination acceptable and the maintenance factor should mean that servicing will be done whenever this minimum is reached.

I HAVE previously commented on the frequency with which articles and reports about lighting appear in non-technical publications. Undoubtedly lighting is "news," and even the "Financial Times" (the "pink 'un" that gives the current values of all the investments I would like to have but haven't got!) devoted no less than one and a half pages of a recent issue to articles on lighting, together with half a page on colour as an aid to industrial efficiency. At about the same time the "City Press" (London) also printed a lengthy article discussing how much light is required by office workers. Unfortunately, the anonymous author of this article did not know that doubling a given illumination does not make things look twice as bright nor make seeing them twice as easy. The relation between illumination and visual sensation and performance is not quite so simple as the author seemed to assume. Had he been better informed on this subject he would not have thought it at all "startling" that the D.S.I.R. Lighting of Buildings Committee recommended 15/20 lm/ft^2 for clerical work although at that time—1950—half the clerical workers in the country were making do with an average illumination of about 8 lm/ft^2.

A CORRESPONDENT has drawn my attention to a letter published in the French paper "Figaro" regarding yellow v. white headlights on cars. The writer of the letter—a resident in Orleans—asks why so many Americans stationed in the locality use white headlamps when French people must use yellow lamps, which are much less dazzling? She thinks that every night the users of the cars with white headlamps risk causing accidents, and she pleads for uniformity in headlamp practice. Well, of course, it is undesirable that some headlamps should be more glaring than others, and the fact that they are so increases the accident risk at night. But, despite French popular opinion, it is not the yellowness of their headlights that makes them less glaring than the white American headlights. Experimental investigation has shown that, for equal beam intensity, there is no significant difference between estimates of glare from yellow and from white headlights and, also, no significant difference in revealing power. But so long as the loss in beam intensity of yellow headlamps is uncompensated by a suitable increase in lamp wattage, it is not surprising that they appear less glaring than the more generally used white lights.

ONE of the criticisms of the flashing beacons at zebra crossings is that, while they indicate the presence of a crossing, they do not adequately illuminate anyone using it. At Croydon a simple modification of the beacons has been demonstrated at one crossing and it is claimed that by this means motorists can see if the crossing is clear while they are still within easy braking distance. The modification consists in forming a small window in each beacon so that when the lamps flash two beams are directed over the crossing. Trials are to be made under different road and weather conditions. Meanwhile, however, vehicle drivers would also like to be able to see anyone who is about to use the crossing but is not actually on it, and it is not clear whether the modified beacons will serve this purpose.